A case study on Maths Dance

The impact of integrating dance and movement in maths teaching and learning in preschool and primary school settings.

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Abstract

The use of kinaesthetic experiences associated with dance to support learning of curricular mathematics has been little represented in the available literature. Maths Dance is an approach to teaching and learning mathematics through dance and movement. The objectives of the study are related to assessing the impact of Maths Dance on students’ cognitive, affective and physical developmental areas in preschool and primary school settings. The investigation of the case study on Maths Dance took place in London, UK, with the participation of four teaching staff members, who were interviewed in detail, and thirty students of Reception, Year 2 and Year 3 classes, out of which eleven students were interviewed. All thirty students were observed once during three Maths Dance sessions, one session per each age group.

Based on a qualitative research approach, the data are analysed and discussed below around seven themes in relation to the theories of constructivism, Dienes’s theory of learning mathematics, Gardner’s theory of Multiple Intelligences and educational neuroscience. According to the main findings, students and teaching staff members express positive attitudes regarding most aspects of the research questions. Specifically, Maths Dance is believed to improve students’ maths skills, critical thinking and creativity, as well as enhance student motivation, socio-emotional and motor skills. The pleasant nature of the activities is also highlighted, an element that is believed to make this method adequate for students of low achievement in maths. However, the small sample size, in addition to the fact that Maths Dance has recently started being implemented in schools, does not permit generalization of the results.
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<th>Abbreviation</th>
<th>Description</th>
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<tbody>
<tr>
<td>BCME</td>
<td>British Congress of Mathematics Education</td>
</tr>
<tr>
<td>CPD</td>
<td>Continuing Professional Development</td>
</tr>
<tr>
<td>DfE</td>
<td>Department for Education</td>
</tr>
<tr>
<td>EAL</td>
<td>English as an Additional Language</td>
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<td>EYFS</td>
<td>Early Years Foundation Stage</td>
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<tr>
<td>FSM</td>
<td>Free School Meals</td>
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<tr>
<td>LAC</td>
<td>Looked After Children</td>
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<td>MI</td>
<td>Multiple Intelligences</td>
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<tr>
<td>NC</td>
<td>National Curriculum</td>
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<tr>
<td>OECD</td>
<td>Organization for Economic Co-operation and Development</td>
</tr>
<tr>
<td>PISA</td>
<td>Programme for International Student Assessment</td>
</tr>
<tr>
<td>PSRN</td>
<td>Problem solving, reasoning and numeracy</td>
</tr>
<tr>
<td>SEN</td>
<td>Special Educational Needs</td>
</tr>
<tr>
<td>STEM</td>
<td>Science, Technology, Engineering and Mathematics</td>
</tr>
<tr>
<td>VAK</td>
<td>Visual-Auditory-Kinaesthetic</td>
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<td>VARK</td>
<td>Visual-Aural-Read/write-Kinaesthetic</td>
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CHAPTER 1

INTRODUCTION

1.1. Background information

Maths is one of the subjects taught in all levels of education as a principal subject. From the first years of their school life, students have to get familiarized gradually with the content and the methodology of maths. However, it is usually observed in different educational systems that the subject of maths is being approached through traditional teaching methods without focusing on the connection that might exist between maths and other fields of knowledge. Even though modern maths teaching methodology offers various possibilities of resolving successfully the complexity of maths by relating it to other sciences (Kurnik, 2008), several non-traditional teaching strategies and techniques are utilized in an attempt to raise student motivation levels and their achievement levels in maths by using computer-assisted instruction programmes or even arts.

The connection between maths and arts has always been present. Maths and art seem to have a long historical relationship since the ancient times; ancient Greeks and Egyptians knew about the golden ratio and incorporated it into the design of monuments such as the Great Pyramid and the Parthenon, while painters, such as Leonardo Da Vinci and Mc Escher used mathematical forms in their work. The interdependence of maths and arts is further demonstrated in the use of mathematical elements of time, tempo and measure in music or in the counting of beats in choreographing movement.

Throughout history educational philosophers, from Aristotle through Dewey, Whitehead and Montessori have encouraged the use of movement to promote learning. Literature revealed several benefits to using movement as a teaching tool. Werner (2001) showed that students in second through fifth grades, who worked with a dancer once a week to learn maths concepts, demonstrated significantly increased positive attitudes toward maths than students who did not work with a dancer. Dienes (1973, 2004) presented an approach on how mathematical structures can be effectively taught from the early grades onwards using games, manipulatives, stories and dance in order to
understand mathematical concepts. Tytherleigh & Watson (1987) explored how dance has been introduced to students to support the learning of curricular mathematics. Similarly, Watson (2005) suggested the use of kinaesthetic experiences associated with dance in teaching to promote engagement and learning in spatial, rhythmic, structural and symbolic aspects of mathematics. Moreover, the choreographer Laban created an educational form of dance using interweaved icosahedra to represent directions and qualities of movement and provided a framework of actions which can be used as a basis for the creation of dances inside the classroom (Laban & Lawrence, 1974; Watson, 2005).

Additionally, the use of an arts-based curriculum at all levels of learning seems to increase students’ internal motivation and decrease behaviour problems (Hooper, 2002). When students are motivated to participate in a task, they are more likely to be receptive to learning. Therefore, several researchers have tried to explore the connection between maths and art. Thurston (1994) includes the kinaesthetic sense in the major divisions that are important for mathematical thinking and claims that people “tend to think more effectively with spatial imagery on a larger scale”.

In parallel to the above, some of the past research has identified a positive relationship between physical activity and academic performance. Hanna (2000) provided arguments for the role dance education plays in stimulating thinking, self-expression and problem-solving by encouraging exploration of time, space, dynamics, phrasing, motif and gesture, while Wood (2008) argued that dance and movement can motivate talk, deepen understandings and engage students in mathematics tasks. Bradley and Stuart (1998) describe a method for introducing choreographic variations using a chaotic symbol-sequence reordering technique. Grant (1985) studied the use of kinaesthetic approaches to teach reading and writing skills to young children at-risk and stated that the physical element of this method proved to be both more effective and more enjoyable for students in the experimental group. In addition to increased knowledge in students about a topic, when dance experiences were added to the curriculum, then the otherwise inappropriate behaviours of challenging students decreased (Griss, 1994). Moreover, Skoning (2008) presented evidence on the potential positive outcomes for students with and without disabilities, when adding dance and
movement activities in teaching instruction. At the same time, several researchers argued that kinaesthetic learning contexts are beneficial in areas of cognitive development such as reading, mathematics, science, and writing (Allen & Butler, 1996; Boykin & Cunningham, 2001; Brooks, 2002; Druyan, 1997; Knight & Rizzuto, 1993; Reynolds et al., 2003; Searson & Dunn, 2001; Worden & Franklin, 1987).

In addition to the above, a study by Reynolds, Nicolson and Hambly (2003) in its examination of movement on multiple variables showed a significant improvement in reading and maths skills for elementary aged students with dyslexia, who followed a particular exercise regime through six months. An earlier study by Knight and Rizzuto (1993) found that the standardized maths and reading achievement scores of students in second, third and fourth grades increased in correlation to the increase in ten balance skills. Exploring the effects of exercise on cognitive functioning, research findings, which showed an increased ability to perform cognitively after exercise, also support the positive effects of kinaesthetic experiences on learning (Hogervorst, 1996; Tomporowski et al., 2005). Similarly, Polatajko et al. (1991) found that elementary students with sensory integration dysfunction improved in reading, writing and mathematics after a six month sensory integration and perceptual-motor therapy. After testing various teaching models, Searson and Dunn’s (2001) study results showed that when teachers used kinaesthetic and tactile teaching techniques in the subject of science, there was a significant improvement in students’ science achievement scores.

1.2. Aims and objectives of the study

The overall aim of this study is to become better acquainted with the teaching/learning method of Maths Dance, which incorporates dance and movement in the teaching and learning of maths. More specifically, the objectives of the study are related to the exploration of the impact of Maths Dance on students’ different domains. Consequently, the main research question is formed as follows:
- How does the application of Maths Dance in school settings impact students’
development based on students and teachers perceptions with prior experience in
Maths Dance?

In this study, impact is considered to be what happens as a result of the Maths Dance
method associated to the effectiveness of integrating kinaesthetic experiences in maths
instruction. Towards this aspect, impact is expected to give a broader understanding on
whether this teaching/learning method is effective or not assessing both the intended
and the unintended outcomes/changes. Consequently, the study will attempt to provide
information in response to the following research questions:

- To what extent does Maths Dance affect students’ knowledge in general
cognitive skills and specifically in mathematics?

- To what extent does Maths Dance affect students’ feelings, attitudes and
behaviours towards learning in general and specifically in mathematics?

- To what extent does Maths Dance affect students’ motor skills?

1.3. Significance of the study

Implications from the studies mentioned above can be reflected in the implementation
of innovative methods of teaching/learning mathematics through dance. Understanding
the different ways through which children learn can inspire the creation of methods
and/or school curricula that integrate movement or other artistic forms of expression in
maths learning instruction. Exploring a possible connection between maths and dance
can lead to further discussion regarding the effectiveness of alternative to the traditional
teaching approaches that might increase students’ motivation and improve their
academic achievement. Therefore, the investigation of the specific teaching/learning
model is expected to result in an interdisciplinary instruction model, which will blend
both maths and dance, so that students can experience how different ways of learning
can contribute to a comprehensive learning experience.
Furthermore, it needs to be mentioned that a similar research was conducted previously by the present instructor of Maths Dance aiming to explore teachers’ and students’ perceptions of the effectiveness and feasibility of a maths lesson incorporating dance in a single primary school class (Baka, 2012). Based on prior knowledge on this topic, the present study warrants closer examination of Maths Dance as such, since its impact on students’ development has not been previously examined in detail. Therefore, the results of this study, which was conducted in different age groups, are expected to provide additional information and further knowledge regarding the specific field of interest.

1.4. Limitations of the study

Assessing the impact of a teaching-learning method in a classroom can be a challenging task. Changes in things such as student attitudes, motivation for learning etc. are difficult to measure with certainty due to the subjectivity of involving human subjects. Furthermore, since Maths Dance is a unique and only recently implemented method, it does not leave space to evaluate the long-term effect, be it positive or negative, on students’ learning.

Moreover, the small sample was another limiting factor of the present research for the generalization of the findings. According to Yin (2012), one of the main challenges of the case study is whether and how to generalize the results, especially when the sample of cases is too small. Additionally, the strict schedule of the observed schools permitted only 5-10 minutes interviewing time with the students, which, in addition to the young age of the student participants, didn’t give enough time for an in-depth interview or for building trust between them and the researcher.
CHAPTER 2

MAIN CONCEPTS AND THEORIES

2.1. Key concepts

2.1.1. School Mathematics

Mathematics (or maths, as it will be considered synonymous in this paper) is unique among all disciplines in terms of its concepts, which have a precise and consistent meaning, and in terms of its results, which are not subject to opinions or experimental verification and remain valid without regard to time, place and culture (Bajnok, 2013).

In order to consider the point of teaching mathematics in school, one needs to raise the question of what is mathematics. Most maths educators argue that it is difficult to give a definition to mathematics. However, the question can be answered in terms of what is considered to be important about mathematics, its place in the curriculum, the content of the curriculum and the pedagogies and resources that are used to develop it (Noyes, 2007).

Much research in mathematics education has highlighted the relationship between teachers’ beliefs about mathematics and their classroom practice, which is important in the context of the discussion in this section. As Hersch (1986, cited in Thompson, 1992: 127) explains: “One’s conception of what mathematics is affects one’s conception of how it should be presented. One’s manner of presenting it is an indication of what one believes to be most essential in it ... The issue, then, is not, What is the best way to teach? but, What is mathematics really all about?”. PISA uses the term mathematical literacy as “an individual’s capacity to identify and understand the role that mathematics plays in the world, to make well-founded judgments and to use and engage with mathematics in ways that meet the needs of that individual’s life as a constructive, concerned and reflective citizen.” (OECD, 2009, p. 84). Throughout this study, the term Maths or Mathematics includes the range of mathematical knowledge and skills contained in a formal school curriculum.
Regarding the place of maths in the curriculum, literature reveals that the school curriculum was principally introduced for the primary level education and contained mainly Reading, Writing and Arithmetic, but when the secondary level curriculum was introduced, this included language, mathematics, science (physics, chemistry, biology), history and geography, and later art and sport (Howson & Wilson, 1987).

Mathematics has now a central place in every school curriculum. Furthermore, learning mathematics is central to the Science, Technology, Engineering and Mathematics (STEM) agenda for industrialised OECD (Organisation for Economic Co-operation and Development) countries; this agenda aims to increase the number of mathematically highly-qualified people in the workforce and extend the mathematical capability of the workforce in order to increase economic growth (OECD, 2011). In parallel, international comparisons of assessment, such as the Programme for International Student Assessment (PISA), influence government perceptions about levels of mathematical skills in school students (Drake et al., 2012). At the same time, although mathematicians have emphasised the importance of problem solving and reasoning for the understanding of mathematical thought, mathematics education in schools all over the world still focuses primarily on the instruction for skill acquisition avoiding serious efforts in promoting deep conceptual understanding, argumentation and creative problem solving (Oers, 2014).

2.1.2. Kinaesthetic learning in students’ learning styles

Regarding his theory of Multiple Intelligences (MI) that is further analysed in Section 2.2.3, Gardner included bodily/kinaesthetic as one out of eight intelligences, acknowledging that people have different cognitive strengths and consequently different learning styles. The bodily/kinaesthetic intelligence involves using one’s whole body or parts of the body to solve problems, create products and convey ideas or emotions (Gardner, 1999; White, 1995). According to Laughlin (1999), people who exhibit a high degree of this intelligence discover environment and objects through touch and movement, learn well by direct observation and participation and remember most clearly what was done rather than what was said or observed, enjoy learning through
activities and experiences, remain sensitive and responsive to physical environments and physical systems and demonstrate skills in athletics, dancing, acting, etc.

Regarding the importance of bodily-kinaesthetic arts in education and its effect on learning, Jensen (2001) argued that “brain research has increasingly shown that the bodily-kinaesthetic arts contribute to the development and enhancement of critical neurobiological systems including cognition, emotions, immune, circulatory, and perceptual-motor [...] The research, the theory, and real-world classroom experience clearly support sustaining or increasing the role of movement in learning” (p. 102). More details related to the connections between movement and learning based on brain research findings can be found in section 2.2.4.

Apart from Gardner’s theory, several learning styles theories have been developed and, appreciating the diversity of learners, they all addressed the need for diversity in teaching instruction in order to improve students’ performance (Miller, 2001). The Visual-Auditory-Kinaesthetic (VAK) model categorises learning by sensory preferences, through which people process information, and it is easily incorporated into school plans (Reid, 2005). Brown (1996) stated that "learning styles research shows that most people prefer learning by experiencing and doing (kinaesthetic elements), especially when reinforced through touching and movement (tactile elements)” (p. 3).

An extension of the VAK model is the VARK (Visual-Aural-Read/write-Kinaesthetic) Learning Styles Inventory, which is used to identify modality preferences and provides a perceptual learning style profile for each student. It was developed by Fleming (2001), who added a fourth category (read/write) by subdividing the visual mode into symbols (visual) and text (read/write) (Miller, 2001). Fleming (2001) defined learning style as “an individual's characteristics and preferred ways of gathering, organizing, and thinking about information. VARK is in the category of instructional preference because it deals with perceptual modes. It is focused on the different ways that we take in and give out information” (p. 1). According to the VARK model, each student can have preference for one of the four perceptual modes, but can learn to function in the other modes. It provides a free VARK questionnaire with thirteen statements, where respondents are asked to choose one out of four possible actions for a described situation. Each one of the four actions corresponds with a VARK learning
style preference. Similarly, there are also differences in learning approaches for the four VARK learning styles; Fleming (2001) suggested a number of learning activities for each learning style based on research results, that indicate higher student performance when there was a match between learning activities and students’ learning styles as determined by the VARK instrument (Hawk and Shah, 2007): a) visual learners prefer maps, charts, graphs, diagrams, brochures, flow charts, highlighters, different colours, pictures, word pictures, and different spatial arrangements; b) aural learners like to explain new ideas to others, discuss topics with other students and their teachers, use a tape recorder, attend lectures and discussion groups, and use stories and jokes; c) read/write learners prefer lists, essays, reports, textbooks, definitions, printed hand-outs, readings, manuals, Web pages, and taking notes; d) kinaesthetic learners like field trips, trial and error, doing things to understand them, laboratories, recipes and solutions to problems, hands-on approaches, using their senses, and collections of samples. Consequently, kinaesthetic learning can be defined as the learning that occurs when students engage in a physical activity, which is learning by doing, exploring and discovering (Fleming and Mills, 1992).

2.1.3. Learning domains

Bloom’s taxonomy model of Learning Domains (Bloom, 1956; 1964) will be used to assess the impact of Maths dance on students. The purpose of the proposed approach is to use the basis of Bloom’s Taxonomy to clearly identify specific outcome indicators by which to evaluate the impact of Maths Dance. The taxonomy clearly identifies different levels of learning in three domains:

- Cognitive domain (mental skills related to knowledge and critical thinking on a particular topic).

- Affective domain (the way to deal with things emotionally, such as feelings, values, appreciations, motivations and attitudes)

- Psychomotor domain (the area of physical movement, coordination and motor skills)
Based on the Bloom’s model, the developmental areas examined in this study are identified as follows:

- Cognitive domain includes maths skills, critical thinking and creativity.
- Affective domain includes student motivation and socio-emotional skills.
- Psychomotor/psychical domain includes motor skills.

2.2. Theoretical background

2.2.1. Constructivism

According to the constructivist approach to teaching, students develop their own understanding of the concepts addressed in the classroom. Several psychological and educational theorists have explored the benefits of experiential learning for children. Montessori argued that children need to be presented with authentic material, through which they will develop intellectually on their own. She believed that learning tasks should be pursued individually at each student’s own interest and that learning would come from the physical interaction with the learning materials and the environment (Montessori, 1965).

Like Rousseau, Montessori, and Piaget, Dewey believed that the physical environment played an important role in children’s learning and he defined experience as the interaction between an individual and his/her environment (Dewey, 1938). Considering Dewey’s pedagogy by engaging students in experiential learning activities, knowledge acquisition and skills development can be promoted through auditory, kinaesthetic and visual modalities. In this way, students establish new schemes associated with the teaching and learning process. In Piagetian terms, this new scheme is open to assimilate previously unfamiliar knowledge and skills and construct new knowledge. The process of the experiences engaging auditory, kinaesthetic and visual capabilities to construct this new scheme is called learning (Brooks and Brooks, 1993). Similarly, Piaget emphasized the learners’ role in constructing meaning out of their...
social interaction with the environment in two ways: a) Learners must inductively discover and transform complex information if they are to make it their own (cognitive constructivism), and b) Social interaction and cooperative learning are important in constructing both cognitive and emotional images of reality (social constructivism).

The idea of movement experiences as a means to integrating new information was identified in Piaget’s stages of child development. Piaget believed that children learn by building cognitive structures in their brains, schema, for understanding the physical experiences in their environment. He concluded that children progress at specific intervals through several stages of development. Three of the four stages are kinaesthetic. Knowledge develops through environmental experiences first in the sensory-motor stage (birth-2 years), then in the preoperational stage (2 – 7 years), and finally in the concrete operational stage (7 – 11 years). The concrete operational stage is the stage that primary grade children are developing in. Piaget claimed that children of this age need to hold and manipulate materials in their environment to develop the intellectual concepts of academics. Furthermore, Piaget stated that children need to be given numerous physical opportunities to learn. When given these opportunities, children will learn on their own, within their stage of development (Singer & Revenson, 1996). Piaget’s theory refers to the term kinaesthetic conflict as a conflict between existing schema and new information, and is the period when new information is introduced and processed through kinaesthetic senses. Therefore, the actions of the body will improve the mind.

Similarly, Vygotsky stated that children thinking and meaning making is socially constructed and emerges out of their social interactions with the environment. He differs with Piaget’s stages of development claiming that there is a difference between learners’ existing developmental state and their potential development with appropriate stimuli (Zone of Proximal Development). Lastly, it has to be mentioned that both Piaget and Vygotsky argued the importance of learning as an interactive experience and the considerable impact that speech combined with action has in child’s intellectual development (Johnston, 2007).
2.2.2. Dienes’s six stages theory of learning mathematics

Dienes (1973b) described six stages that should be considered in the learning process on mathematics education: (1) free play, which concerns the creation of an empirical environment to help the child form logical concepts; (2) games, which relates to the invention of games with rules that match the rules that are inherent in some piece of mathematics, which the educator wishes the learners to learn; (3) comparison, where learners are encouraged to take the first steps towards abstraction through music, motion, physics, dance and/or language; (4) representation, where learners have identified the abstract content of games and seek ways to represent the common cores of various activities through e.g. an arrow diagram or any other visual or auditory representations; (5) symbolization, in which a symbol system can be developed and used to describe the properties of the system being learned; (6) formalization, in which learners establish descriptions that can lead to axioms, theorems and proofs. Dienes’s most important contribution in the field of mathematics education is related to his theories of how mathematical concepts and structures can be effectively taught using manipulatives, dance, games, and stories (Dienes, 1973a).

2.2.3. Gardner’s theory of Multiple Intelligences

Gardner’s (1983, 1993) theory of MI has served as the basis for the development of curricula that have been implemented at a number of schools. His theory described that people can learn through eight domains of intelligence (and the potential of a ninth intelligence), each of which operates independently. In other words, a person can perform low or high in one certain intelligence regardless of his or her level on the other domains of intelligence. This set of intelligences, which are used by individuals to solve problems or answer questions, are the following: Linguistic, Musical, Mathematical, Visual-Spatial, Bodily-Kinaesthetic, Intrapersonal Intelligence, Interpersonal Intelligence, and Naturalist Intelligence (Gardner, 1983). MI theory supports teachers’ beliefs that students learn in a variety of ways. Gardner argued that his theory “respects the many differences among people, the multiple variations in the ways that they learn,
the several modes by which they can be assessed, and the almost infinite number of ways in which they can leave a mark on the world" (Armstrong 1994, p. vii).

Gardner’s research also deals with the integration of art abilities (theatre, dance, music etc.) and its relation to intelligence in the educational process. Gardner’s theory provided a framework for the use of arts integration, which made teachers able to create lessons that engage learners and increase student achievement. Furthermore, Campbell and Campbell (1999) presented information from six schools that had an increase in student achievement as a result of implementing MI strategies; many of these schools used curricula which were taught in an interdisciplinary manner.

2.2.4. Educational Neuroscience

Traditionally mind and body have been understood to be two distinct substances, where material things can be observed and measured objectively, while mental things can only be experienced subjectively. Many theorists in this field support the idea that there is a connection between the body and the mind, such as Kolb (1984) who described knowledge as a result of the combination of grasping and transforming experience in his theory of experiential learning. Similarly, the fields of kinesiology, neurology, cognitive neuroscience, and neurobiology have explored the physical processes of the brain and their relationship to cognition; relevant research from cognitive neuroscience supports kinaesthetic approaches to brain-based learning and connections between movement and learning (Ratey, 2002). In the past decade, the discipline of educational neuroscience -reflecting an interdisciplinary dialogue between cognitive neuroscience and educational psychology- brings neuroscientific insights into the understanding of the learning process. Findings from brain research, recognising the close interdependence of physical and intellectual well-being and the close interplay of the emotional and cognitive, the analytical and the creative arts, address the need for holistic teaching strategies that involve the co-ordination of multiple brain structures to support Maths education (OECD, 2007). Moreover, Sousa (2006) addresses the ways that arts can impact the brain and the cognitive and socio-emotional development
emphasizing on the neurological benefits of dance and movement to improve brain performance.

As a result, educators and researchers applied the findings of brain research to guide teaching practices through the development of the brain-based learning theory. The brain-based theorists and educators have taken the abovementioned available information and explored the question of what effects do using kinaesthetic learning opportunities have upon cognitive development. These theories are also supported by the magnetic resonance imaging of the areas of the brain involved during various cognitive processes and physical movements (Kolb, 1984; Ratey, 2002; Zull, 2002). However, much of the research supporting kinaesthetic approaches to brain-based learning has not been published in peer-reviewed journals, which is a limiting factor for providing deeper understanding of the connection between brain performance and kinaesthetic learning.

Figure 1: Theoretical framework of the study
CHAPTER 3

RESEARCH METHODOLOGY

3.1. Research strategy

The underlying perspective of this study is qualitative as the most appropriate approach for collecting rich and meaningful empirical evidence. Denzin and Lincoln (2005) define the qualitative research as:

...a situated activity that locates the observer in the world. It consists of a set of interpretive, material practices that makes the world visible. These practices transform the world. They turn the world into a series of representations, including field notes, interviews, conversations, photographs, recordings and memos to the self. At this level, qualitative research involves an interpretive, naturalistic approach to the world. This means that qualitative researchers study things in their natural settings, attempting to make sense of, or to interpret, phenomena in terms of the meanings people bring to them” (p. 3).

There is also a simpler definition offered by Nkwi, Nyamongo, and Ryan (2001): “Qualitative research involves any research that uses data that do not indicate ordinal values” (p. 1), which focuses on the fact that the data generated and/or used in qualitative research are non-numerical (text, sounds, images etc.).

Since this research is qualitative, it focuses on a real-world setting exploring how people act in that setting enabling the researcher to conduct an in-depth study (Yin, 2011). By exploring participants’ perspectives and reflections on Maths Dance, the study provided deeper understanding of the specific teaching/learning method. The two main methods of data collection were semi-structured interviews and participant observations.
3.2. Research design

The technique that provided the framework for the collection and analysis of the data is the case study method. The basic case study is identified as the detailed and intensive analysis of a single case (Bryman, 2012. Since the study needed to investigate the impact of Maths Dance in students’ different learning domains, three similar case studies were observed in order to get an in-depth understanding of how Maths Dance affects several aspects, such as student performance in maths, motivation towards learning, physical development etc.

A multiple-case study approach was adopted for the research. The cases that were examined were three schools in the area of London, where Maths Dance sessions are taking place by the same maths teacher. The instruction method of Maths Dance presents unique features in its design and implementation, which results in an idiographic approach of the cases (Bryman, 2012). Maths Dance as such is only implemented currently in Preschool X, Primary School 1 and Primary School 2, which offer Maths Dance sessions in the form of school clubs. There is also a fourth primary school that offered Maths Dance previously and was therefore not available for observation, but for a detailed interview with one of the interviewees participating in this study; all four schools are located in London area.

Additionally, in all three schools/cases the Maths Dance lessons took place in the school premises as an extracurricular activity. As they were not part of the school curriculum, they were held once a week during one hour for each case/school every Thursday and Friday respectively. The three sessions were observed (two of them were photographed), as well as students, teachers and a school principal were interviewed (in the following pages all four interviewees will be referred to as educators). As it was mentioned before, the first case school is a preschool, while the other two case schools are primary schools. Thus, it is acknowledged that during the final data analysis multiple interpretations might exist and, therefore, as much as possible was done in order to prevent the researcher from imposing her own interpretation of the data onto the participants’ interpretation (Yin, 2011).
3.3. Data collection methods

3.3.1. Semi-structured interviews

In the social research interview, the aim is for the interviewer to derive from the interviewee or respondent information regarding interviewee’s own behaviour, attitudes, norms, beliefs and values or that of others (Bryman, 2012). Both educators and students were interviewed in order to elicit information related to their views towards Maths Dance (see Appendix C). A semi-structured interview was used in both cases, since this form allowed more general questions and the potential of further questions depending on interviewee’s replies. However, the interview questions for the educators were more detailed and complex, while the interview questions for the students were shorter and simpler due to the limited time allowed by the school to conduct them.

The student interviews were conducted directly after each Maths Dance session in the same classroom and were held in focus groups, apart from the case of Primary School 1, where one student only provided parental consent to be interviewed. Yin (2011) identifies focus groups as individuals who previously had some common experience; in this study they all participated in Maths Dance sessions.

Figure 2: Interview with the focus group at Preschool X
The interviews with the educators were conducted individually with each person in a classroom or staff room inside the respective school. All interviews included open questions that provided useful information about Maths Dance, an area in which the researcher had limited knowledge. All answers were recorded in a recording device and were transcribed upon finalization of each interview capturing words verbatim (see Appendix D). It needs to be mentioned that Appendix D contains all the participants’ interviews with reduction or selection of the original data, due to the small available research sample and its significance for a better understanding of the little-studied approach of Maths Dance. The inclusion of all interviews in full length in the Appendix was considered appropriate for this study, because the purpose here is not to generate a representative sample and then generalise the results, but to learn from people who might have different perspectives on the approach and can best help to understand the specific interest of this study.

3.3.2. Structured observation

Classroom observations were a necessary component of this study in order to provide a clear understanding of how Maths Dance is implemented. This research tool was used in order to observe systematically the behaviours of the students and the instructor, as well as the interaction between them during three Maths Dance sessions (approximately 180 minutes of observation). In this case the non-participant researcher was seen as a research tool taking notes throughout the implementation of the activities following the information included in the Observation Guide (see Appendix B). In other words, the researcher had a passive role during the observation in order to record whatever was happening at the time of the Maths Dance session. However, the reactive effect of the participants, which might have influenced the reliability and validity of the results, should be taken into account.

3.3.3. Selection of the schools and interviewees

The examined population consisted of:

a) Preschool students of Preschool X attending Maths Dance sessions;
b) Primary school students of Primary School 1 attending Maths Dance sessions;

c) Primary school students of Primary School 2 attending Maths Dance sessions;

d) Educators of Preschool X, Primary School 2 and Primary School X with prior experience in Maths Dance;

e) Instructor of Maths Dance in all the above settings.

In this case, the sample was chosen in a deliberate manner, known as purposive sampling (Yin, 2011). Consequently, the sample included almost the whole population of the units involved in Maths Dance. Accordingly, the sample size is formed as follows:

a) 30 students were observed, out of which 11 were interviewed

b) 4 educators

Four educators were interviewed in order to explore their perceptions on the impact of Maths Dance in different areas of students’ development. As presented in Tables 1 and 2 below, there were two type of interviews conducted for the research: the first type of the interviewed participants consisted of the Maths Dance instructor and three educators, who observed Maths Dance session/s previously, while the second group of interviewees were students of pre-school and primary school age level, who were observed during one Maths Dance session.

Table 1: Educators participating in the interviews

<table>
<thead>
<tr>
<th>Educators interviewed</th>
<th>Gender</th>
<th>Position at the school</th>
<th>Experience with Maths Dance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interviewee A</td>
<td>Female</td>
<td>School Principal in Preschool X</td>
<td>Observed two sessions</td>
</tr>
<tr>
<td>Interviewee B</td>
<td>Male</td>
<td>Year 4 teacher, Arts Coordinator in Primary School X</td>
<td>Observed one session</td>
</tr>
<tr>
<td>Interviewee C</td>
<td>Female</td>
<td>Maths Coordinator (primary school) in</td>
<td>Observed one session</td>
</tr>
</tbody>
</table>
Table 2: Students participating in the interviews and observations

<table>
<thead>
<tr>
<th>Schools observed</th>
<th>Number of students participating in the activities</th>
<th>Number of students participating in the interview</th>
<th>Age</th>
<th>Number of Maths Dance sessions attended prior to observation</th>
</tr>
</thead>
</table>
| Pre-school X     | 6                                                | 6 (group interview)                           | 4-5 years old (Year Reception) | 8
| Primary School 1 | 4                                                | 1 (individual interview)                      | 6-7 years old (Year 2)        | 15
| Primary School 2 | 20                                               | 4 (group interview)                           | 7-8 years old (Year 3)        | 3

3.4. Issues of reliability, validity and ethics

According to Bryman (2012), reliability is related to the question of whether the results of the research study are repeatable. In order to assess the reliability of the method, the procedures that constitute this method must be replicable by someone else. Another criterion of research is the validity, which is concerned with the integrity of the conclusions resulting from the research. Since it is a qualitative study, it might be relevant to the criterion of external validity to set the basis for further research and give answer to the question of whether the results of this specific case study can be generalised beyond the specific research context, for example in other countries, other settings etc. According to Yin (2011) “a valid study is one that has properly collected and interpreted its data, so that the conclusions accurately reflect and represent the real world that was studied.” (p. 78).
An additional principle that strengthened the validity of the study was the triangulation, meaning the researcher’s goal to seek information in collecting the data from at least three different kinds of sources that led to the same findings (Yin, 2011). Specifically, the study focused on the events that the researcher observed during the sessions (direct observation, photos), detailed information provided by the designer and instructor of Maths Dance (in-depth interview, lesson plans), reported views by educators (in-depth interviews) and students’ opinions (short interviews). However, since this research study adopted a case study design, it needs to be mentioned that the goal was not to generalise the findings, but rather present findings of the investigation of a specific case, that is the impact of the instruction of Maths Dance in three schools in London.

Moreover, in order to build the trustworthiness and credibility of the study, three objectives are proposed by Yin (2011):

- Transparency: The research procedures should be described in a way that people can review and understand them, as well as all data should be available for inspection.

- Methodic-ness: The research should follow a certain set of procedures avoiding unexplained bias.

- Adherence to evidence: the research should be based on an explicit set of evidence.

Additionally, regarding the ethical principles in social research, this study was designed taking into consideration the following criteria:

1. The likeliness of real or potential harm to participants.

2. Receive informed consent from parents/carers (since children are below 18 years old) and/or teaching professionals.

3. Not invade the right to privacy of those being studied.

4. Ensure that research participants are not deceived.
As a matter of conducting an ethical study, pseudonyms were used to protect the participants. The researcher offered each of the participants a full copy of the methodology section of the study along with the informed consent form for interviews and observations (see Appendix A). In parallel, the research followed certain guidelines derived from the British Sociological Association’s (BSA) Statement of Ethical Practice and the Economic and Social Research Council’s (ESRC) Framework for Research Ethics while aligning with the UK Data Protection Act (1998).

3.5. Data analysis

3.5.1. Thematic Analysis

Approaches to qualitative data analysis are numerous. In this research the analysis had a descriptive and exploratory orientation. In an exploratory study the researcher carefully reads the data identifying commonalities, key words or trends that will help form the analysis, which is not specifically designed to confirm hypotheses, but is used to generate hypotheses for further study through research questions (Guest et al., 2012). During the analysis the intention was not to build a new theoretical model but to use the theory as a direction for what to examine and how to examine it.

Thematic analysis is a method that is often used to analyse data in primary qualitative research and can be defined as a qualitative analytic method for “identifying, analysing and reporting patterns (themes) within data. It minimally organises and describes your data set in rich detail. However, frequently it goes further than this, and interprets various aspects of the research topic” (Braun and Clarke, 2006, p.79). Applying the above definition in this research, the objective was to select the key points of the interviews and understand the transcribed text in relation to the research questions focusing on key issues and finding commonalities among research participants. The reason why this particular method was chosen for the data analysis is related to Braun and Clarke’s views (2006) stating that the thematic analysis does not require a detailed existing theoretical framework, it can be used within different theoretical frameworks
and it can, therefore, offer a more accessible form of analysis, especially for those less experienced in qualitative research.

According to Braun and Clarke (2006), there are six phases in conducting thematic analysis and these are the following: 1) Becoming familiar with the data; 2) Generating initial codes; 3) Searching for themes; 4) Reviewing themes; 5) Defining and naming themes; 6) Producing the report. Based on the above guide, the researcher went through the following steps:

- Interview transcription: All interviews were transcribed, including as much as possible non-verbal points (e.g. hmm, uh etc.), pauses while talking, emotional reactions (laughing, emphasizing) etc.

- Familiarity with the data: The researcher got familiar with the data through the transcription of the interviews and the repeated reading of them noting some initial ideas.

- Create the initial codes: Several interesting points were identified within the data and were coded in a systematic way and relevant excerpts from the transcribed texts were added under each code.

- Search for themes: Codes were consolidated into potential themes gathering all relevant data under each theme.

- Control of the themes: It was checked if the themes were making sense in relation to the coded text extracts, and thus a thematic map of the analysis was formed.

- Definition and description of themes: The analysis continued in order to determine in detail the characteristics of each theme generating clear definitions and names for each theme.

- Production of reference: The most characteristic and relevant passages were being selected and further analysed, while it was checked the extent to which the analysis was relevant to the research questions and the literature.
3.5.2. Themes

A theme “captures something important about the data in relation to the research question and represents some level of patterned response or meaning within the data set” (Braun and Clarke, 2006, p. 82). In other words, themes are recurrent and distinctive features of participants’ accounts, characterising particular perceptions and/or experiences, which the researcher sees as relevant to the research questions of a particular study (King and Horrocks, 2010). In qualitative research, themes are identified at a semantic/explicit level or at a latent/interpretative level (Boyatzis, 1998). In a semantic approach the analyst is not looking for anything beyond what a participant has said or what has been written, whereas a thematic analysis at the latent level examines the underlying ideas, assumptions, conceptualizations and ideologies that are theorized as shaping or informing the semantic content of the data (Braun and Clarke, 2006). Commenting upon inductive versus theoretical thematic analysis, Braun and Clarke (2006) explain that the themes can be identified either in inductive “bottom-up” way, where themes are developed inductively from the data, or in a theoretical deductive “top-down” way, where themes are informed by theory or practice (Symon and Cassell, 2012).

Figure 3: Identified themes for data analysis
In the present research, the analytic process involved the organization of the data in themes, in order to show patterns more in a semantic rather than in a latent content. Furthermore, the analysis lay between bottom-up and top-down styles of analysis with themes deriving both from the data and the existing literature/theory; this means that on one side the themes identified were strongly linked to the data themselves and therefore the thematic analysis was data-driven, but at the same time, some of the themes were defined in advance based on the researcher’s theoretical interest, such as the three domains in children’s development based on Bloom’s taxonomy model. Consequently, the themes identified were the following:

- **Theme 1: Impact of Maths Dance on students’ cognitive domain**
  - Sub-theme 1: Maths skills
  - Sub-theme 2: Critical thinking
  - Sub-theme 3: Creativity
- **Theme 2: Impact of Maths Dance on students’ affective domain**
  - Sub-theme 1: Student motivation for learning
  - Sub-theme 2: Social skills
- **Theme 3: Impact of Maths Dance on students’ physical domain**
- **Theme 4: Educational climate during the activities**
- **Theme 5: Target groups**
- **Theme 6: Students’ overall impressions**
- **Theme 7: Disadvantages/Suggestions for improvement**
CHAPTER 4

CONTEXT OF THE STUDY

4.1. A National Strategy for Numeracy

As mentioned by Noyes (2007) in 1988 the National Curriculum (NC) for England and Wales introduced ten foundation stages, which aimed to:

1) provide opportunities for all students to learn;

2) promote spiritual, moral, social and cultural students’ development, and prepare them for the experiences of the adult life.

However, at the time of its introduction the mathematics curriculum received critique for failing to meet the second abovementioned aim and for being centralised. The NC did not change the criticism on mathematics education, but led to the introduction of the National Numeracy Strategy in an attempt to transform the classroom pedagogy and attitudes in learning mathematics. According to the (DfE) Department for Education (2013), the current NC for mathematics aims to ensure that all students:

- become fluent in the fundamental of mathematics, so that they can develop conceptual understanding and the ability to recall knowledge accurately;
- reason mathematically by developing an argument using mathematical language;
- can solve problems by applying their mathematics to a variety of problems with increasing sophistication.

Additionally, according to the UK’s National Numeracy Strategy, children need to acquire appropriate mathematical language because a) it is crucial to their development of thinking, and b) through mathematical vocabulary they can participate in the activities, lessons and tests that are part of the classroom life (DfE, 2000). However, there are students of attainment below age-related expectations in numeracy. According to DfE (2012) these groups include: boys, students eligible for Free School Meals
(FSM), some ethnic minority groups, students with English as an Additional Language (EAL), students with Special Educational Needs (SEN), students with high rates of mobility between schools and Looked After Children (LAC). Therefore, the DfE (2012) suggests interventions for effective numeracy teaching in primary and secondary school levels.

4.2. Maths education in UK preschool settings

All schools and officially registered early years’ providers must follow the EYFS (Early Years Foundation Stage), including child-minders, preschools, nurseries and school reception classes. The EYFS contains a list of standards for the learning, development and care of all children in the UK from birth to five years old. Additionally, frequent assessments based on practitioners’ observations take place at the end of the academic year and the information retrieved is used for parents, practitioners and teachers to support children’s learning and development. The DfE identifies seven areas of early years learning split between prime and specific areas of learning (Table 3).

Table 3: Areas of early years learning

<table>
<thead>
<tr>
<th>Prime areas</th>
<th>Specific areas</th>
</tr>
</thead>
<tbody>
<tr>
<td>communication and language</td>
<td>literacy</td>
</tr>
<tr>
<td>physical development</td>
<td>mathematics</td>
</tr>
<tr>
<td>personal, social and emotional development</td>
<td>understanding the world</td>
</tr>
<tr>
<td></td>
<td>expressive arts and design</td>
</tr>
</tbody>
</table>

PSRN (Problem solving, reasoning and numeracy) is one of the areas of the EYFS principles of learning and development. In the EYFS Framework is stated that children must be provided with the opportunities to develop their understanding on PSRN, practise their skills in these areas and gain confidence and competence in their use. PSRN contains the following aspects:
- Numbers as labels and for counting: children use numbers and counting in play, to develop mathematical ideas and to solve problems.

- Calculating: children develop awareness of the relationship between numbers and amounts and know that numbers can be combined.

- Shape, space and measures: children develop appropriate vocabulary through talking about shapes and quantities and solve mathematical problems.

Mathematical knowledge at this level is identified regarding the development of the skills mentioned above, which will further help children solve problems, produce new questions and make connections across other areas of EYFS Framework in learning and development.

### 4.3. Maths education in UK primary school settings

The NC is divided into four Key Stages that children are taken through during their school life.

<table>
<thead>
<tr>
<th>Key Stage 1</th>
<th>Ages 5-7</th>
<th>Years 1 and 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Key Stage 2</td>
<td>Ages 7-11</td>
<td>Years 3, 4, 5 and 6</td>
</tr>
<tr>
<td>Key Stage 3</td>
<td>Ages 11-14</td>
<td>Years 7, 8 and 9</td>
</tr>
<tr>
<td>Key Stage 4</td>
<td>Ages 14-16</td>
<td>Years 10 and 11</td>
</tr>
</tbody>
</table>

All maintained schools (state schools mandated for or offered to all children without charge) in England are required to follow the NC. However, academies and Free Schools are not required to follow the NC, but are required to provide a broad and balanced curriculum which includes English, mathematics, science and religious education. Beyond this, they have the freedom to design a curriculum which meets their students’ needs, aspirations and interests.
Taking into account recent information from DfE and according to the current NC programmes of study, maths remains a compulsory subject at all four Key Stages, and the existing programmes of study and attainment targets remain statutory for pupils in Years 1, 2, 5 and 6 in 2013 to 2014. On 11 September 2013 the Secretary of State for Education published the new national curriculum framework following a series of public consultations. The majority of the new NC will come into force from September 2014, so schools have a year to prepare to teach it. From September 2015, the new NC for English, mathematics and science will come into force for years 2 and 6; English, mathematics and science for Key Stage 4 will be phased in from September.

In the primary schools being studied, the participants of Primary School 1 belong to Key Stage 1 (Year 2), while participants of Primary School 2 belong to Key Stage 2 (Year 3). The UK Department for Education provides a range of resources and materials in the mathematics area of the Primary Framework to support the development, planning and teaching for all aspects of mathematics. Details regarding the Mathematics Framework for Year 2 and Year 3 are mentioned in the two following sections.

4.3.1. Key Stage 1: Mathematics Framework for Year 2

During Key Stage 1 students develop their understanding and knowledge of mathematics through practical activity, exploration and discussion. Students learn to count, read, write and order numbers to 100 and beyond. They develop a range of skills in calculating and learn to use these skills confidently in different settings. Moreover, through practical exercises they develop their knowledge about shape and space, which builds on their understanding of their immediate environment. They also learn to use mathematical language when explaining their reasoning and methods in problem solving. When students enter Key Stage 1, their prior knowledge in mathematics includes:

- counting and using numbers to at least 10 in familiar contexts
- recognising numerals 1 to 9
- talking about and creating simple patterns
• beginning to understand addition as combining two groups of objects and subtraction as 'taking away'  
• describing the shape and size of solid and flat shapes  
• using everyday words to describe position  
• using early mathematical ideas to solve practical problems.

During the Key Stage 1, students should be taught the knowledge, skills and understanding through:

a) practical activity, exploration and discussion  
b) using mathematical ideas in practical activities, then recording these using objects, pictures, diagrams, words, numbers and symbols  
c) using mental images of numbers and their relationships to support the development of mental calculation strategies  
d) estimating, drawing and measuring in a range of practical contexts  
e) drawing inferences from data in practical activities  
f) exploring and using a variety of resources and materials, including ICT  
g) activities that encourage them to make connections between number work and other aspects of their work in mathematics.

Furthermore, the planning structure for the subject of maths for Year 2 is organised into five blocks (Table 5), where each block is designed to cover the equivalent of six or nine weeks of teaching and is made up of three units. The blocks are:

• Block A: Counting, partitioning and calculating  
• Block B: Securing number facts, understanding shape  
• Block C: Handling data and measures
- Block D: Calculating, measuring and understanding shape

- Block E: Securing number facts, relationships and calculating

### Table 5: Planning structure for Year 2 maths

<table>
<thead>
<tr>
<th>Focuses of mathematics learning</th>
<th>Block A</th>
<th>Block B</th>
<th>Block C</th>
<th>Block D</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Place value in 2- and 3- digit numbers</td>
<td>Addition and subtraction facts to 10; pairs that sum to 20; multiples of 10 that sum to 100</td>
<td>Sorting information on a diagram using one or two criteria</td>
<td>Mental calculations: adding and subtracting 1-digit number or multiple of 10 to/from a 2-digit number</td>
</tr>
<tr>
<td></td>
<td>Partition into multiples of 10 and ones</td>
<td>Tables for 2, 5 and 10</td>
<td>Organising information using lists and tables</td>
<td>Informal written calculations: adding and subtracting 1- and 2-digit</td>
</tr>
<tr>
<td></td>
<td>Comparing, ordering, reading and writing 2-digit and 3-digit numbers</td>
<td>Doubles of numbers to 10; corresponding halves</td>
<td>Presenting data in block graphs and pictograms</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Use the &lt; and &gt; symbols</td>
<td>Solving problems involving numbers, money or measures, using addition, subtraction, multiplication or division</td>
<td>Collecting, organising, presenting and interpreting data to answer questions</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Patterns and sequences</td>
<td>Patterns, relationships and properties of numbers and shapes</td>
<td>Identifying further questions</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Counting on and back in steps of different sizes</td>
<td>Estimating and checking answers</td>
<td>Choosing and using appropriate units of measure and measuring equipment</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Odd and even numbers</td>
<td>Describing and visualising properties of common 2-D and 3-D shapes</td>
<td>Measuring and comparing lengths, weights and capacities using standard units</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mental methods</td>
<td>Line symmetry</td>
<td>Using ICT</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Addition/subtraction of 1- and 2- digit numbers</td>
<td>Sorting and making shapes</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
numbers
- Following and giving instructions for movement using mathematical language
- Solving problems involving numbers, money, measures or time
- Estimating, comparing and measuring lengths, weights and capacities
- Using units of time and reading time to the quarter hour
- Reading scales and interpreting the divisions

<table>
<thead>
<tr>
<th>Block E</th>
<th>Counting on and back from different numbers in 2s, 5s and 10s</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Building up the 2, 5, or 10 times-tables</td>
</tr>
<tr>
<td></td>
<td>Finding half, quarter and three quarters of shapes and sets of objects</td>
</tr>
<tr>
<td></td>
<td>Doubles of numbers to 20 and corresponding halves</td>
</tr>
<tr>
<td></td>
<td>Describing patterns and relationships involving numbers or shapes and testing examples that fit conditions</td>
</tr>
<tr>
<td></td>
<td>Solving problems using counting, the four operations and doubling or halving in practical contexts, including measures or money</td>
</tr>
<tr>
<td></td>
<td>Using the symbols +, −, ÷ and = to describe, record and interpret number sentences</td>
</tr>
<tr>
<td></td>
<td>Multiplication as repeated addition and arrays</td>
</tr>
<tr>
<td></td>
<td>Division as sharing and repeated subtraction (grouping)</td>
</tr>
</tbody>
</table>


4.3.2. Key Stage 2: Mathematics Framework for Year 3

During Key Stage 2 students learn to use the number system more confidently. They move from counting reliably to calculating fluently with all four number operations. They also explore features of shape and space and develop their measuring skills in a range of contexts. They use a wide range of mathematical language, as well as diagrams and charts in order to discuss and present their methods and reasoning.

During the Key Stage 2, students should be taught the knowledge, skills and understanding through:

a) activities that extend their understanding of the number system to include integers, fractions and decimals

b) approximating and estimating more systematically in their work in mathematics

c) using patterns and relationships to explore simple algebraic ideas
d) applying their measuring skills in a range of contexts

e) drawing inferences from data in practical activities, and recognising the difference between meaningful and misleading representations of data

f) exploring and using a variety of resources and materials, including ICT

g) activities in which pupils decide when the use of calculators is appropriate and then use them effectively

h) using mathematics in their work in other subjects.

Similar to the planning structure for Year 2, is the structure of the subject of maths for Year 3, which is divided in the same five blocks with the difference that each block incorporates more advanced mathematical objectives (Table 6).

<table>
<thead>
<tr>
<th>Block A</th>
<th>Focuses of mathematics learning</th>
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<tbody>
<tr>
<td></td>
<td>▪ Addition and subtraction</td>
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<td></td>
<td>▪ Mental methods: 1- and 2-digit numbers</td>
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<td></td>
<td>▪ Written methods: 2- and 3-digit numbers</td>
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<td></td>
<td>▪ Reading, writing, ordering, partitioning and rounding 2- and 3-digit numbers</td>
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<td></td>
<td>▪ Solving one- and two-step word problems involving numbers, money or measures</td>
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<td>▪ Explaining methods and reasoning, orally and on paper</td>
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<td></td>
<td>▪ Multiplication and division</td>
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<td></td>
<td>▪ Multiplying 1- and 2-digit numbers by 10 or 100</td>
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<td></td>
<td>▪ Informal written methods: multiplying and dividing TU by U; rounding remainders</td>
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<tr>
<th>Block B</th>
<th>Focuses of mathematics learning</th>
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<td></td>
<td>▪ Recognising, using and drawing right angles</td>
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<td></td>
<td>▪ Drawing and comparing angles</td>
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<td></td>
<td>▪ Dividing and recalling number</td>
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<td>Block C</td>
<td>Block D</td>
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<tr>
<td><em>Reading times and calculating time intervals</em>&lt;br&gt;<em>Sorting information using lists, tables and diagrams</em>&lt;br&gt;<em>Presenting data in frequency tables and bar charts</em>&lt;br&gt;<em>Collecting, organising, presenting and interpreting data to follow a line of enquiry</em>&lt;br&gt;<em>Identifying further questions</em>&lt;br&gt;<em>Choosing and using appropriate units of measurement</em>&lt;br&gt;<em>Knowing relationships between units of measure</em>&lt;br&gt;<em>Using ICT</em></td>
<td><em>Understanding multiplication and division as inverse operations</em>&lt;br&gt;<em>Using inverses to estimate and check calculations</em>&lt;br&gt;<em>Developing written methods of calculation for all four operations</em>&lt;br&gt;<em>Finding unit fractions of numbers and quantities</em>&lt;br&gt;<em>Solving problems and representing information; set solutions in the context of the problem</em>&lt;br&gt;<em>Using measures and scales</em>&lt;br&gt;<em>Comparing angles with right angles</em>&lt;br&gt;<em>Using the vocabulary of position, direction and movement</em></td>
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4.4. **Maths Dance approach**

Maths Dance is about teaching and learning mathematics through movement and was firstly introduced in primary schools in London in January 2013. Since then it has been implemented as such in school clubs, Continuing Professional Development (CPD) sessions, workshops and seminars. It promotes the connection of mathematics and dance through a holistic educational scheme, where all learning areas are linked and taught together (Maths Dance, 2014).

During the Maths Dance school clubs, mathematics and dance are used together to enrich and support learning of curriculum maths. Students are given the opportunity to explore numbers, shapes and space while practising dance through building up maths inspired choreographies (ibid.). Maths Dance school clubs take place during early morning, lunchtime or after school clubs. Additionally, Maths Dance has been presented in the BCME (British Congress of Mathematics Education) Conference in April 2014 introducing suggestions to teachers for creating their own Maths Dance lessons (BCME, 2014).
CHAPTER 5

PRESENTATION AND ANALYSIS OF RESEARCH FINDINGS

5.1. Impact of Maths Dance on students’ cognitive domain

The first area that was considered important for assessing the impact of Maths Dance was on students’ cognitive development. In this research, cognitive development will be examined in terms of better understanding in maths, improvement of critical thinking and analysis, improvement of creativity and support for students with learning difficulties. These areas form the sub-themes of Theme 1.

5.1.1. Maths skills

First of all, all school staff members that were interviewed agreed on the dual role of Maths Dance both as an artistically and a theoretically orientated activity. Regarding this aspect, the Maths Dance instructor states that:

*Interviewee D: The relationship between mathematics and dance in a Maths Dance lesson is symbiotic, balanced and bidirectional. In that sense, there is an equal emphasis given to talking and thinking about maths and physically doing it.*

The views of two educators, who have observed one and two sessions of Maths Dance respectively, also agree with the above statement:

*Interviewee A: I believe that Maths Dance can be seen both as an artistically and a theoretically orientated activity, it is both maths and dance.*

*Interview C: I kind of saw it as 50-50, but I thought that there was a nice combination between maths and dance, especially for a lot of children who*
actually like dance, it might be that they see it more as dance and then the maths is just kind of sneakily put in there.

Only Interviewee B claimed that Maths Dance was more related to maths than to dance.

Interviewee B: When I saw it, I saw it more of a maths activity but it’s something that was dance, but it wasn’t totally dance, which is good I think, and although boys were quite rigid, all the children liked it and then discretely they said “Oh, that was it? Yes, we had fun!”, but yeah, I would say more of a maths activity than a dance activity.

So, since the interviewees agreed on the mathematical orientation of the examined process, then Maths Dance needs to target certain maths skills for students to achieve. One of the important areas of maths teaching and learning is related to maths concepts that students have to understand in each level of education as instructed by the NC.

Figure 4: Use of mathematical vocabulary at Primary School 1

Recognising the importance of arts education for better understanding in maths, all interviewees mentioned different ways of how the integration of kinaesthetic activities
through Maths Dance can contribute to maths learning and improve students’ maths skills. Three interviewees emphasized on the fact that the incorporation of kinaesthetic activities into teaching can make maths seem more practical and less abstract, which can help further in memorizing and better understanding complex maths concepts. More specifically, Interview A stated that it can support certain type of learners:

*I think it works perfectly for kinaesthetic learners, for developing number, shapes and space.*

On the same direction, Interviewee B, when explaining an example of a student from his class with short attention spanner, stressed the fun element of incorporating movement into teaching:

*Interviewee B: But there is a fun element about that, so if you are doing clapping and clapping with your knees it’s a lot more fun rather than using numbers, rather than using symbols which are quite abstract... So, in that sense I believe it can improve short term memory and sequential thinking. I can name about 5 children here who would need that.*

Similarly, the Maths Coordinator of Primary School 2 agreed with the rest of the interviewees on the positive effects of kinaesthetic activities for improving students’ maths skills:

*Interviewee C: It can definitely help students memorising and better understand complex mathematical concepts and especially to understand the fact that maths can be practical first and then they can understand it on paper.*

Lastly, the Maths Dance instructor argued that the fun element, which was also mentioned by Interviewee B, can be responsible for improved maths skills:

*Interviewee D: Mathematics becomes fun and entertaining. This automatically changes the students’ attitude towards the subject and increases the possibility of improving levels.*

Furthermore, in order to support the beneficial character of Maths Dance being a multisensory teaching and learning approach, she used the recent neuroscientific
research, which stresses the importance of integrating movement activities into everyday learning:

*Interviewee D: A lesson which includes a variety of methods and stimuli (physical, visual and auditory) is likely to keep more children engaged and for more of the time than an approach that just relies on one single method. Thus, the stimulation of multiple sensory experiences (speech, actions, pictures, symbols) can enhance memorising and offer deeper understanding of a new concept... This is what brain-compatible learning is about: teaching mathematics and all other subjects along with movement, drama and the arts.*

She also continued by claiming that the different context in which mathematical concepts are introduced in Maths Dance, encourages students to view these concepts from a different conceptual perspective:

*Interviewee D: Perceptual and mathematical variability are the two parameters that enhance the two basic cognitive processes in maths: abstraction and generalisation.*

### 5.1.2. Critical thinking

When the interviewees A, B, C and D were asked about their opinion regarding the connection between Maths Dance and the encouragement of critical thinking and analysis, all of them replied in a positive manner.

In the relevant question “*In what ways do you think that Maths Dance could encourage students’ critical thinking and analysis?*” Interviewee B replied with an example of an activity explaining that Maths Dance gives initiative to the children and freedom to create their movements that are their own and that they can change in various ways, which can therefore encourage critical thinking. On the other hand, Interviewee C stressed the fact that the group work, which is mainly promoted in Maths Dance activities, can create space for discussion on what worked or didn’t work throughout the process and help them in their self-assessment.
Interviewee C: Well, it’s hard to say judging only from one session that I observed but it might help them[students] to understand possible mistakes or misconceptions. I think that when they are working in a group, it gives them more of an opportunity for them to discuss, for example “that worked, that didn’t work”, so it definitely encourages that kind of discussion which will then lead in some mathematical discussion anyway.

In the respective question, the Maths Dance instructor (Interviewee D) explained in detail how she plans and develops all the activities with the aim to encourage students’ engagement in thinking about fundamental mathematical ideas and statements. The creative and kinaesthetic nature of the activities gives students the opportunity to provide multiple solutions to a single problem; the realisation that there are more than one answers to a question, in combination with the time and space that students are given in order to explore the mathematical concepts in depth, are believed to support the development of critical thinking. For example, this last statement was shown during the observation in the Preschool X at the paired activity “Number Bonds to 10”, where the first student in each pair was asked to choose a “secret” number smaller than 10 (0,1,2,3,4,5,6,7,8 or 9) and then the second student needed to touch the first student with as many parts of his/her body as the number needed to be added to the “secret” number in order to make 10. During this activity students were given the chance to explore the multiple correct ways to solve the problem.

Figure 5: Paired activity “Number Bonds to 10” at Preschool X
5.1.3. Creativity

Creativity is one of the main characteristics of Maths Dance. During the observations, one could clearly identify multiple occasions where students were using their imagination and creativity to create various movements individually, in pairs or with the whole group as a response to a mathematical question or problem. Moreover, at the end of each lesson students were producing a choreography that was inspired by the maths knowledge taught on that day, which was then added to the choreographies of the previous Maths Dance sessions, in order to build up and present a maths-inspired choreography at the end of each term.

Figure 6: Creative movement activity at Primary School 1

The issue of creativity was discussed by all interviewees. Interviewee A stated that since Maths Dance is an arts-orientated activity, it can definitely improve students’ creativity:

*Interviewee A: They use creative movement in various instances and the whole idea of understanding maths through movement is creative by itself anyway.*
Similar to the above view is the opinion of Interviewee C, who also highlighted the fact that students are given the chance to experiment with their bodies and link maths with dance; this link can encourage students’ creativity.

*Interviewee C: I think dance is very creative anyway and I think that just being able to make the links between maths and then make a dance out of it, that definitely encourages creative thinking. It gives them freedom to experiment different things which encourages creativity.*

Additionally, Interviewee B, despite stressing the fact that it might not always work that well for male students because of feeling intimidated towards the dance element of Maths Dance, claimed that the integration of movement brings opportunities for the creation of various mathematical concepts, such as shapes, sequences etc.

*Interviewee B: You are quite free to create sequential movements or even shapes or even anything through movement, but yes, it does take quite of a lot for boys to get involved into it.*

5.2. Impact of Maths Dance on students’ affective domain

Following Bloom’s taxonomy model, the second area of assessing the impact of Maths Dance is in students’ affective domain. In this paper, the affective domain is the area that includes students’ motivation for participating in the learning process, as well as the social and emotional skills that are encouraged during the process. These two areas form the sub-themes for Theme 2.

5.2.1. Student motivation for learning

The fun element, which was also discussed previously in this chapter, was one of the main reasons why interviewees think that Maths Dance makes students more motivated to participate and more engaged to learning compared to traditional methods of teaching and learning.
Interviewee A: It could definitely help in that way; improve students’ motivation etc., because it’s basically fun for everyone to participate.

Additionally, Interviewee B also agreed with the fact that Maths Dance could promote student motivation and all students could enjoy the activities; the students’ motivation would depend upon the way that the instructor presents to them the whole process, as maths or as dance. He also argued that the fact that students can get up and move and not just sit, could encourage their participation and engagement in the learning process:

In Maths Dance they can be more engaged, it’s more of an engaging opportunity for students because it’s quite fun, who cares if you make a mistake, we are all working towards the same goal.

Interviewee C also stressed the importance of students to enjoy the activities, which could further change their attitude towards maths and help them understand difficult maths concepts. He continued by stating that:

If they can start enjoying the process, then they will enjoy an aspect in maths and then they will be motivated to learn more [...]. If they enjoy the process, they are more willing to participate in the activities.

At this point it’s also important to acknowledge the intention of Maths Dance in that perspective as mentioned by its instructor. She believes that encouraging students to express themselves freely and take risks during the activities are elements that make maths enjoyable, help them make sense of maths and can motivate them to participate in the whole learning process.

Interviewee D: Mathematics becomes fun and entertaining. This automatically changes the students’ attitude towards the subject and increases the possibility of improving levels.

Although most activities required previous mathematical knowledge, the nature of the activities as such was adequate for the students to express themselves freely without the fear of being right or wrong.
Interviewee D: First of all, students feel ok with making mistakes. Secondly, I always make sure that the activities are all open-end and very often there are multiple answers to the questions I pose. They realise that there is not always and necessarily one correct answer to a mathematical question; consequently, their attitude towards maths changes.

5.2.2. Socio-emotional skills

In terms of encouraging social skills, it was observed that most of the activities were implemented either in pairs or with the whole group. When the students were asked to give an answer to a mathematical question, they were sitting all together discussing possible solutions. Furthermore, the maths-inspired choreographies at the end of each session and based on maths concepts taught the same day or already taught previously, were created and implemented through group work as well. As Interviewee D mentioned, in some of the sessions she splits the group in a group of “mathematicians” and a group of “dancers”, where both have to teach each other:

As I said before, students participate in the learning process through group work, through sharing and teaching each other [...]. They are not afraid to express their ideas and take risks, which makes their self-respect and self-esteem grow bigger. I also very often split the group into “mathematicians” and “dancers” and I then ask them to work on a task in pairs or small groups, where mathematicians work in collaboration with the dancers. Through this process they are all motivated to teach each other and share their knowledge with the group.

The promotion of group work and partnership throughout the implementation of the activities was also noticed by Interviewee C:

I guess in a lot of stuff they did there is quite a lot of paired work, so again it took two of them to kind of be able to complete the routine together, so they have to kind of help each other if one of them did go wrong, so it kind of helps them in this self-assessment.
Furthermore, Interviewee B clearly stated that Maths Dance could improve students’ self-confidence:

*I think it could certainly help with some of the less able children to kind of increase their self-confidence.*

Even during activities in which students had to think individually about possible answers to a mathematical question, they were given enough time to think without feeling the pressure of having to reply quickly enough before another student is quicker and replies first or raises the hand to show he/she knows the answer, an action which could create anxiety or loss of interest in searching for a possible answer since someone else has already found it. Regarding this point, the Maths Dance instructor used a game in order to avoid “faster” kids replying quickly to a question or raising their hand and as a result make the “slower” students feel nervous or not quick/good enough. First, the students were asked a question or problem, then they had to think about it for some time and if a student knew the answer he/she would start doing a movement to let the others know that he/she is done; when every student was moving/dancing around, this meant that everybody finished thinking of possible solutions to the question; only at the end of this process they were asked to give the answers and reflect on them with the whole group and the instructor.

In addition to the above, it was also stated that the way through which the activities were conducted, could decrease the anxiety levels in students who labelled themselves as not being good at maths:

*Interviewee C: Through Maths Dance they can see maths in a different way, like not be completely turned off by the subject and get anxious. [...] If you got a child who is really not enjoying the subject and feels very anxious about it, then probably whatever you are trying to do is not going to be that successful, because the child is just not confident.*

She continued by stating that even male students, who were a bit uncertain and uncomfortable with dance in the beginning, they went on with it after a while.
The same view was mentioned by Interviewee B, who added that the level of engagement of those intimidated students, mainly boys, would depend on the instructor’s approach:

It would depend upon the way that she might do it, how she could work with those children who frankly find dance kind of intimidating; but they could enjoy, it’s something that they should be quite up for. […]Although boys were quite rigid, all the children liked it and then discretely they said “Oh, that was it? Yes, we had fun!”.
5.3. Impact of Maths Dance on students’ physical domain

Since Maths Dance is about incorporating movement and dancing in the teaching and learning process of maths, movement/dancing objectives are an integral part of the activities along with maths learning objectives. Besides, the impact of Maths Dance on various areas of students’ physical development was recognised by all interviewees judging by their experience as observers of previous Maths Dance sessions.

*Interviewee A:* In the observation that I had, I could see that they were counting and moving and the language of maths is in there as well, you know, turning right, turning left, facing this way, that way, and I think that’s very important.

*Interviewee B:* So, if children do have problems with their coordination, well then that would really help pushing them up in different ways, so yes this maths training or dance training session, would help them work out special things, be aware and think “Is there someone close to me?”; same thing if you are working in groups, 2-4-6; you can try different movements and ask the children “Can you hold someone while you are doing this movement?” etc.

*Interviewee C:* Well, I think them being required to do big movements and fine movements, they are having to do so many skills and move so much that they are – without even realising it- working on them. Obviously we have seen only a few topics being taught at the moment, but they were going from bigger movements to smaller movements and it was really good to see them develop different mathematical concepts through movement. I remember that there was also a bit of balance element involved when they were working with number bonds, so yeah I suppose that in lots of levels can Maths Dance improve their motor skills.

Similarly, Interviewee D stressed the importance of supporting kinaesthetic experiences and explained how she promotes creative movement through her approach:

*Movement is an intrinsic part of the learning process. The creation of choreographies is also an important part of the lesson. Students inevitably improve their motor skills. It’s also important that I become a role model for*
kinaesthetic development. I move around all the time, demonstrating the activities and showing them how to channel their energy into creative movement.

In terms of supporting motor skills, the table below shows clearly the specific movement objectives for each observed session per case school, as those were identified in the relevant lesson plans (see Appendix E).

Table 7: Movement objectives for the observed Maths Dance sessions

| Preschool X | • To explore different actions and gestures with others and in a specific sequence.  
| | • Use six basic dance actions (travel, turn/rotation, jump, stillness, fall, gesture).  
| | • Use isolated parts of the body: joints, muscles, limbs, or surfaces. Example: nose, elbows, spine, thigh, shoulder, sole of foot, etc.  
| | • Timing/ Variations of speed and rhythm. Example: stillness, slow motion, slow, regular or even beat, fast, repetition, irregular beat. Double time: twice as fast. Half time: half the speed.  
| | • Creation of phrases (a movement combination or section of choreography).  
| | • Creation and composition of dance (choreography).  
| Primary School 1 | To explore different actions and gestures with others and in a specific sequence.  
| Primary School 2 | To explore different qualities of actions in space.  

5.4. Educational climate during the activities

The data included in this theme are based on field notes, which were taken by the researcher during the observations. The data presented below are related to aspects of teaching that could only be noticed by direct observation, but not by voice recording, such as eye contact between instructor and students, use of humour, use of instructional materials etc. and describe the general atmosphere at the time of the delivery of the activities.

Regarding the verbal and non-verbal communication between students and the Maths Dance instructor, it was observed that she kept eye contact with all students and used their names frequently throughout the process. In addition to that, relevant maths vocabulary was used by both the instructor and the students, such as clockwise/anti-clockwise, first/second/third etc., terms of the pattern, one quarter/two halves etc., once/twice/three times, multiply/divide etc. (see Appendix E).

Figure 8: Interaction between students and Maths Dance instructor at Primary School 1
All sessions were conducted in an open space room (without desks or chairs) within the school premises, where students had enough space to move around. In terms of instructional materials selected, tape/rope or fabrics were used to formulate shapes, mini-white board where necessary, while music was accompanying all the activities.

Moreover, in the three sessions all present students were participating in the activities and clear instructions were given to them prior each activity. However, some cues of boredom were presented towards the end of the session at the students of Preschool X. Furthermore, there was a clear difference in terms of the contextual understanding of the activities between the students of Primary School 1, who seemed to be better acquainted with the philosophy of Maths Dance, and the students of the other two case schools, who had less experience with Maths Dance.
5.5. Target groups

Since Maths Dance is provided as a school club and is not part of the curriculum in the three case schools, the orientation of the activities is different between them; that is, in Preschool X, the Maths Dance instructor was asked to develop activities that are more entertaining rather than strictly pedagogical, whereas in the cases of Primary School 1 and Primary School 2 the objectives of the Maths Dance activities were targeting students of low achievement in maths. However, all interviewees recognised the support that Maths Dance could provide to students who either have difficulties in learning or need to improve their maths skills.

More specifically, Interviewee A argued that Maths Dance could be introduced as an alternative to traditional methods of instruction, that have proved to be unsuccessful for some students, especially for those considered to be kinaesthetic learners:

*It could help students with learning difficulties and also reluctant learners seem to have a block about what maths is, you know, Maths Dance could be a way into learning if they are resistant to some of the more traditional methods. I think it works perfectly for kinaesthetic learners, for developing number, shapes and space; I could see how that could be useful.*

Similar to the above statement, Interviewee B agreed that it could be particularly helpful for students, who find it difficult to follow the fast paced lesson in an ordinary classroom or have difficulties related to short term memory and sequential thinking. However, he recognised the benefits of Maths Dance for all students regardless of their abilities in maths:

*I’m thinking of about 6 children who, because it’s quite fast paced, some of them would have to keep up and they would find it a bit of a struggle in the classroom; but in Maths Dance they can be more engaged, it’s more of an engaging opportunity for students because it’s quite fun, who cares if you make a mistake, we are all working towards the same goal. […]Basically I wanted to see how she could communicate to less able children the idea about sequential movement and putting things in orders etc., which I think she did pretty successfully, but not just*
for the less able children, but also for the more able mathematicians, they were able to stretch themselves and put several sequences together using mathematical language, which went very very well. [...] So, in that sense I believe it can improve short term memory and sequential thinking. I can name about 5 children here who would need that.

And he continued by giving an example of one of his students, who showed improvement in maths skills after attending Maths Dance.

Interviewee B: One of my students joined Maths Dance in the mornings and it had helped him focus and put things in sequential order.

Additionally, Interviewee C stated that Maths Dance was initially targeting students who were underachieving in maths hoping that it would make them see maths in a more enjoyable way:

The initial idea was to introduce it to students, who had specific difficulties in maths, but not only just to address the difficulties but maybe also to change the perception of maths subject.

The inclusive nature of the approach is also stated by Interviewee D, along with details regarding specific age-groups that have attended Maths Dance lessons:

Since founding Maths Dance in January 2013 I have collaborated with primary schools and have worked with students aged 4 to 11 years old. That is students in Year Reception up to Year 6.

Considering the school level where Maths Dance could be taught, the rest of the interviewees (Interviewees A, B and C) mentioned that it would be more adequate for preschool or primary school students. Their perspective on this aspect was contradicted by the opinion of Interviewee D, who claimed that it can and will also be soon implemented in secondary schools.

Interviewee A: Maths Dance could really work for students, especially in primary school, who think that maths cannot be an enjoyable topic. [...] I can’t imagine it being used for more advanced mathematics.
Interviewee B: So, I can see that there is more connection in terms of kinaesthetic activities, especially for preschool and primary school students, maybe less for secondary students. Year 4 and 5 that’s probably the highest you could go, then year 6 might think it’s silly, but certainly preschool students would love that.

Interviewee C: I think that in a secondary school it might not go down so well because the kids might not feel comfortable with doing maths through dance.

Interviewee D: However, Maths Dance can be taught to secondary schools as well. There are many KS3 and KS4 mathematical areas that can be approached, explored and communicated through movement. For example, sets of numbers, fractions, ratio and proportion, formulas, equations, coordinates and line graphs, angles, parallels, symmetry, translation and enlargement, representing data and probability. In the 2014 summer term Maths Dance will be taught to a college in the UK and in the 2014 autumn term we will work with secondary schools in London.

Lastly, it needs to be mentioned that, although all interviewees agreed that Maths Dance can be beneficial for supporting learning for students with learning difficulties, they also stated that it should not be seen as a replacement for current teaching methods, but as an additional part of the maths teaching and learning process.

5.6. Students’ overall impressions

Students’ impressions are analysed as these were declared by the interviewees, as well as the students themselves. Additional evidence was provided from the field notes of the observed sessions.

Based on their experience of previous Maths Dance sessions, all interviewees described positive students’ overall impressions towards Maths Dance.

Interviewee A: They were enjoying showing each other the work that they have done. So there was enjoyment and concentration actually, which was good.
Interviewee B: Although boys were quite rigid, all the children liked it and then discretely they said “Oh, that was it? Yes, we had fun!”.

Interview C: Although there were different levels of enthusiasm between boys and girls, they all went on with it and enjoyed the activities.

Interviewee D: Students love Maths Dance. The atmosphere is always very positive. Of course it always takes a couple of weeks for the children to come closer as a group and understand the philosophy of the lesson, but generally speaking, I create a safe and positive learning environment, where every single child is given the opportunity to excel.

When students were asked to give their opinion regarding Maths Dance, their answers seemed to confirm the above views. Specifically, all the students replied positively showing their excitement and enthusiasm. Three of them explained that they particularly enjoyed the dancing part of the process and one of them stressed the mathematical aspect of the activities. In the question “What do you like more in Maths Dance?”, preschool students replied the following:

Preschool X/Child A (girl): That we dance!

Preschool X/Child B (girl): That we learn more maths and I like maths. I like it because when we do Maths Dance, we do games with maths and this is what I like.

Preschool X/Child C (girl): I like dancing, so I like Maths Dance.

Preschool X/Child D (boy): I like it because you dance.

The student of Primary School 1 focused her reply on the entertaining combination of Maths and Dance:

It’s fun, because it’s maths, which is quite fun, and I love the songs and the dances we do and all of this stuff. Well, you do really fun dances and I really like the way we did the dancing, because it’s really fun. You do Maths with your body which is quite fun. And I like the fractions. Because you dance to a fraction.
Similarly, the students of Primary School 2 mentioned that they prefer Maths Dance to a traditional maths lesson.

*Primary School 2/Child A*: I like it because in the classroom we only sit down and write and it’s boring, but here we got to move around all the time.

*Primary School 2/Child B*: It’s really fun to dance like numbers and shapes. I enjoy it a lot.

*Primary School 2/Child C*: I like moving and running. I liked the music also. It’s better than sitting in the same position and write.

5.7. Disadvantages/Suggestions for improvement

Regarding possible disadvantages of Maths Dance, Interviewee A explained why a Maths Dance session has to be age-appropriate. When comparing the two Maths Dance sessions that she observed, she noticed that the first session wasn’t age-appropriate for the specific group; however, she further explained that this was early detected by the Maths Dance Instructor, who adjusted the activities on students’ abilities:

*Interviewee A*: It has met my expectations and I think that she has been very responsive to the group that she’s got. The first thing that I saw it was just too difficult for the children and then she’s just brought it down to exactly the right level.

Although Interviewee B agreed that Maths Dance could be a part of a school curriculum, he expressed concerns related to the variety of topics that can be introduced through this method:

*There is a restriction according to what specific subjects you could do.*

However, Interviewee D contradicted the above view by stating that:
However, Maths Dance can be taught to secondary schools as well. There are many KS3 and KS4 mathematical areas that can be approached, explored and communicated through movement.

Furthermore, Interviewee C recognised the fact that boys weren’t so excited to participate:

*I think the general point was that some of the boys weren’t that keen, because we picked a mixed group and that might be a stereotypical thing, yeah, because it’s quite often that girls choose dance, but boys weren’t so excited with the fact that it was dance.*

She also suggested that it would be more beneficial, if the Maths Dance instructor could collaborate with the maths teacher, so that she can include in the sessions knowledge that was not adequately understood in the ordinary maths classroom.

*Interviewee C: I think maybe making sure that Maths Dance is related to the units taught in the class. Since it’s an after school club, it would be helpful to identify the gaps and see what they didn’t get in the classroom and then bring it and work with this knowledge in the Maths Dance session, but, yeah, that would require more organization from the school, but I’m sure that it would be good.*

Additionally, Interviewee D discussed future opportunities of offering Maths Dance to students from disadvantaged backgrounds, as well as students with special educational needs:

*If we get funding, we will be able to offer Maths Dance in more schools at a very low cost giving the opportunity to students especially in disadvantaged areas to experience it. [...] I always ask feedback from other teachers and the participants to the workshops that I am offering, and one of the suggestions I had was to develop Maths Dance further as an approach to cover special educational needs.*

Lastly, when students were asked whether they would like to change anything in the Maths Dance lesson, some of them expressed the desire for bigger number of students attending the sessions.
Primary School 1/Student: Hmmm, I don’t know. I like it like this. Maybe it could be more fun if more children wanted to come.

Primary School 2/Child B: I would like more children to come and do it with us.

Primary School 2/Child C: The teachers talked to all the children about it, so maybe more children will come.
6.1. Discussion of main findings

In the present study, the general aim was to explore further an alternative maths teaching and learning approach that incorporates kinaesthetic activities in maths learning. Observations and interviews were conducted in order to explore in details some basic elements of Maths Dance and give to the reader an overview of the method. Furthermore, the objectives of the study were related to the assessment of the impact of Maths Dance in different areas of preschool and primary school students’ development and particularly the positive or negative effects of the method on their cognitive, affective and physical development. On a secondary level, both teachers’ and students’ responses, in combination with direct observations of Maths Dance sessions, revealed additional aspects of the new method.

As it is drawn from the detailed analysis above, the majority of the participants responded positively in almost all aspects of the research enquiries. Educators, that observed previously one or two Maths Dance sessions, recognised the mathematical orientation of the method and stressed the importance of incorporating kinaesthetic activities in maths learning in order to improve students’ maths skills in terms of memorizing and better understanding complex mathematical concepts. The close interdependence of physical and intellectual well-being, as promoted through Maths Dance teaching, reflects relevant findings from cognitive neuroscience, that support kinaesthetic approaches to brain-based learning and connections between movement and learning (Ratey, 2002). The aspect of creativity was also mentioned in various instances, since it is considered an arts-orientated activity offering many opportunities for creative movement and delivery of mathematically-inspired choreographies.
Moreover, the promotion of collaborative and team work throughout the Maths Dance activities, where students were expressing their opinion freely and were finding solutions to mathematical problems discussing them with the whole group, is aligned with the work of Vygotsky and Piaget, who argued that children’s thinking and meaning making is socially constructed and emerges out of their social interactions with the environment.

Additionally, it needs to be mentioned that in some of the activities maths was the starting point and dance was the result, while other activities started from dance, through which the students eventually reached maths. Since all the activities involved some kind of movement, Maths Dance inevitably had a direct impact on students’ motor skills. Therefore, apart from maths orientated objectives, the three lesson plans included specific movement objectives as well.

Furthermore, the entertaining and enjoyable nature of the activities was stated by both the educators and the students. The fun element of the activities was responsible for keeping students engaged in the learning process and increasing their motivation for participating in their learning of new concepts. This aspect reflects Dienes’s theories of how mathematical concepts and structures can be effectively taught using manipulatives, dance, games, and stories (Dienes, 1973a). The use of relevant maths vocabulary was an integral part of the instruction, which is aligned with the UK’s National Numeracy Strategy stating that children need to acquire appropriate mathematical language, because it enables them to participate in maths activities and is important for their development of thinking (DfE, 2000).

Moreover, it was thoroughly discussed that Maths Dance could be particularly helpful for students, who either have difficulties in learning or need to improve their maths skills, especially for those considered to be kinaesthetic learners. This encompasses Gardner’s theory of multiple intelligences, which includes the Bodily-Kinaesthetic Intelligence in the set of intelligences, through which individuals solve problems or answer questions, explaining that students learn in a variety of ways. Gardner’s research also deals with the integration of art abilities (theatre, dance, music etc.) and its relation to intelligence in the educational process by providing a framework for the use of arts integration, which made teachers able to create lessons that engage
learners and increase student achievement. All the Interviewees believed that Maths Dance could improve maths skills in students of low achievement in maths and stated that it could also be helpful for children with SEN.

In addition to the above, students’ overall impressions were positive as these were described by both the educators and the students’ themselves. Maths Dance made mathematics learning more pleasant and enjoyable than a traditional maths lesson and kept them engaged in the learning process. However, boys from older age groups were mentioned to be less motivated to participate in the activities.

Lastly, apart from the fact that male students seemed to be less excited, one of the main disadvantages of Maths Dance, according to students’ opinion, was the small size of the Maths Dance groups and many of them mentioned their desire for more students attending the sessions. Moreover, the interviewed educators were doubtful regarding the use of Maths Dance to teach advanced mathematics, which was contradicted by the Maths Dance instructor’s beliefs for planning to implement the method in secondary schools in the near future. Considering suggestions for further improvement, it is important to mention the close collaboration between the maths teacher and the Maths Dance instructor in order to identify gaps in students’ maths learning, as well as future opportunities for offering Maths Dance to children with SEN.

6.2. Conclusion and recommendations

The approach of integrating dance and movement in maths teaching and learning has been examined in relation to its impact on different areas of development for students in preschool and primary school settings. The study examined the connections between maths and dance, and presented students’ and teaching staff’s perceptions towards the alternative approach of Maths Dance. The findings showed that there are certain benefits of incorporating kinaesthetic activities in maths teaching and learning. The analysis of the findings presented positive experiences regarding the nature of the method and the delivery of the activities in terms of enhancing better understanding of mathematical concepts and memorizing, increased motivation and encouraged creativity.
and partnership. The negative responses of the participants were limited to less boys feeling motivated to participate in Maths Dance, as well as the need for bigger number of students attending the sessions. It would also be recommended to find ways to relate Maths Dance activities to mathematical units taught in the classroom.

Acknowledging the existence of kinaesthetic intelligence, as this was defined by Gardner (1999) among several types of intelligences, gives space for expanding the assessment of children’s potential in school, which in most cases is focused on two intelligences only, linguistic intelligence and logical-mathematical intelligence. The key point in Gardner’s theory of MI is that, by recognising the diversity of children, it appreciates that intelligence and ability should not be dominated only by language skills. This approach can be used for students’ assessment and for teaching all areas of the curriculum. By identifying learning styles instruments, the teacher can obtain useful knowledge on students’ strengths and weaknesses, which will provide information for planning, developing and teaching. An important consideration, that is often overlooked, is the diversity of learners and the implications for respective classroom instruction in order to provide students with the best educational experience. If educators identify all students’ learning styles and accommodate all learners’ preferences, student motivation and performance will improve.

Furthermore, it would be interesting to explore parents’ perspectives on the approach regarding aspects, such as why they have chosen to register their children in a Maths Dance club, what were their expectations from it, how they would describe their children’s impression about it etc.

Last but not least, it is proposed that future research should concentrate on examining the effectiveness of Maths Dance when applied to students with SEN, because a) some of the children who have learning disabilities, emotional disorders, attention deficit disorder, cognitive disabilities, and gifts and talents, may be kinaesthetic learners, b) most of the teachers focus on linguistic or mathematical teaching strategies in teaching, in which students with SEN have difficulty anyway, c) even when adopting movement activities in the classroom, these are rarely connected to the curriculum in meaningful ways, and d) dance might be beneficial for students who have difficulty expressing themselves orally or in writing.
In conclusion, the limited research into the possible benefits of alternative to the traditional methods in order to approach learning and in particular maths learning, suggests the need for further investigation of adopting kinaesthetic teaching approaches with potential benefits both to inclusive classrooms and to all students.
REFERENCES


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Appendix A: Consent forms

Informed Consent Form (for parents of students under 18 at schools participating in the research)

Title of the research: A case study on Maths Dance: The impact of integrating dance and movement in maths teaching and learning in preschool and primary school settings.

Researcher’s statement
This is a parental permission form asking you to allow your child to take part in a research study. The information provided below aims to inform you about what will happen in the study and help you decide if you want your child to participate in it. Taking part in the research is voluntary. If you choose not to have your child join the study, it will not affect their care at the school. If you decide that your child can take part in this study, you would sign this form to confirm your decision.
I sincerely appreciate your cooperation. If you would like to receive more information about the study, please contact me at p.evangelopoulou@gmail.com.
Thank you.

Part I: Information Sheet

1. Description of the study
The study aims to examine the integration of dance and movement in maths learning and teaching and its impact on different areas of students’ development attending lessons of maths dance in preschool and primary school settings in London area. The impact element will include physical, social and cognitive benefits and impacts, as well as outcomes related to intended and unintended behaviours, attitudes and skills of students participating in Maths Dance lessons. Lastly, possible limitations and challenges of the maths dance method will also be examined.

2. Procedures
Students will be observed by the researcher during one Maths Dance session. After the completion of the session, students will be asked to answer short questions related to their views on Maths Dance. All the above will take place in March during the
prescheduled hours for Maths Dance in the school premises. The interviews will be recorded and held in groups; no-one else but the researcher will be present unless your child asks for someone else to be there (e.g. their teacher). If your child does not wish to answer any of the questions during the interview, he/she may say so and the researcher will move on to the next question.

3. Benefits
There will be no immediate and direct benefit to your child or to you, but your child’s participation is likely to help us find out more about the impact of Maths Dance on children’s development and we hope that this will initiate further research on creative learning and teaching methods in the future.

4. Risks
There are no potential harms, discomforts, physical or psychological risks if your child takes part in the study.

5. Confidentiality
The identities and records of individuals will be maintained as confidential and particular care will be taken with regard to the possible identification of persons and places. The research follows certain guidelines derived from the (British Sociological Association) BSA’s Statement of Ethical Practice and the (Economic and Social Research Council) ESRC’s Framework for Research Ethics. According to the UK Data Protection Act (1998) all personal information will be fairly and lawfully processed and will be used only for research purposes in a manner which will not allow identification of individual responses.

6. Questions
If you wish to ask questions now or later, you may contact:

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<th>Research student</th>
<th>Research supervisor</th>
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<tr>
<td>Name</td>
<td>Polyxeni Evangelopoulou</td>
<td>Mikiko Cars</td>
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Part II: Certificate of Consent

I give my permission for my daughter/son to participate in this research study and I am aware that I can withdraw my consent or discontinue participation at any time. I understand that all the information provided during the observation and interviews will be treated in confidence and that my identity and that of my daughter/son will be protected in possible future publication of any findings.

__________________________
Printed Name of Research Participant

__________________________
Printed Name of Parent or Legal Guardian

__________________________
Signature of Parent or Legal Guardian

Date

Researcher’s signature

I have fully explained the research study described by this form. I have answered the participant and/or parent/guardians questions and will answer any future questions to the best of my ability. I will tell the family and/or the person taking part in this research of any changes in the procedures or in the possible harms/possible benefits of the study that may affect their health or their willingness to stay in the study.

__________________________
Printed Name of Researcher Obtaining Parental Permission or Consent

__________________________
Signature of Researcher Obtaining Parental Permission or Consent

Date

Please return this form to school as soon as possible
Title: A case study on Maths Dance: The impact of integrating dance and movement in maths teaching and learning in preschool and primary school settings.

Researcher’s statement
This consent form is a permission form requesting you to take part in a research study. The information provided, below, aims to inform you about what will happen in the study and help you decide if you want to participate in it. Participation in this research study is voluntary. Should you choose not to participate, know that this will not affect your work at the school. If you decide that you can take part in this study, you would need to sign this form to confirm your decision.
I sincerely appreciate your cooperation and will provide you with additional information about the study, should this be desired. Please feel free to contact me at p.evangelopoulou@gmail.com.
Thank you.

Part I: Information Sheet
1. Description of the study
The study aims to examine: the integration of dance and movement in maths learning and teaching and its impact on different areas of students’ development who participate in Maths Dance in preschool and primary school settings in London. This includes physical, social and cognitive benefits and impacts, as well as outcomes related to intended and unintended behaviours, attitudes and skills of students participating in Maths Dance lessons. Lastly, possible limitations and challenges of the Maths Dance method will also be examined.

2. Procedures
Students will be observed by the researcher during one Maths Dance session. After the completion of the session, students will be asked short questions related to their views on Maths Dance. All the above will take place in March 2014 during the pre-scheduled hours for Maths Dance on the school premises. The interviews will be recorded and held in groups. No other person apart from the researcher will be present, unless the
child asks for someone else to be there (e.g. their teacher). If students do not wish to answer any of the questions during the interview, they may say so and the researcher will move on to the next question. The Maths Dance instructor, teaching staff members and school principals of the respective schools will also be interviewed individually; all interviews will be recorded.

3. Benefits
There will be no immediate and direct benefit to the students or teaching staff members, but their participation is likely to help us find out more about the impact of Maths Dance on children’s development and we hope that this will initiate further research on creative learning and teaching methods in the future.

4. Risks
There are no potential harms, discomforts, physical or psychological risks if the students or teaching staff members take part in the study.

5. Confidentiality
The identities and records of individuals will be maintained as confidential and particular care will be taken with regard to the possible identification of persons and places. The research follows certain guidelines derived from the British Sociological Association’s (BSA) Statement of Ethical Practice and the Economic and Social Research Council’s (ESRC) Framework for Research Ethics. According to the UK Data Protection Act (1998) all personal information will be fairly and lawfully processed and will be used only for research purposes in a manner which will not allow identification of individual responses.

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If you wish to ask questions now or later, you may contact:

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I give my consent to participate in this research study and I am aware that I can withdraw my consent or discontinue participation at any time. I understand that all the information provided during the interview will be treated in confidence and that my identity will be protected in possible future publication of any findings.

[Printed Name of Teaching professional]

[Signature of Teaching Professional]

[Date]

Researcher’s signature

I have fully explained the research study described by this form. I have answered the participants’ questions and will answer any future questions to the best of my ability. I will inform the person taking part in this research of: any changes in the procedures; any possible harms; any possible benefits of the study that may affect their health or their willingness to stay in the study.

[Printed Name of Researcher Obtaining Permission or Consent]

[Signature of Researcher Obtaining Permission or Consent]

[Date]
Appendix B: Observation Guide

(adapted by the Community College of Aurora’s Mentor Program Handbook and Staffordshire University’s “Guidelines for the Observation of Teaching”)

1. Development of learning objectives:
   • Are objectives for the class given verbally, written, or not at all?
   • Are specific instructional outcomes used?
   • Are objectives discussed at the end of class?

2. Selection and use of instructional materials:
   • Do films, websites, and other audio-visual materials have a clear purpose?
   • Are hand-outs used? Are they appropriate in number and subject?
   • Since the text may be pre-selected, does instructor give help with reading or using the text, if necessary?

3. Educational climate for learning:
   • Are students and teacher interested and enthusiastic?
   • Does the instructor use student names?
   • Is humour used appropriately?
   • Does instructor not embarrass or belittle students in any way?
   • Is the atmosphere of the classroom participative?
   • Did the instructor have eye contact with students?

4. Variety of instructional activities:
   • Does timing of classroom activities consider attention spans?
   • Does instructor involve students in deciding what issues to discuss?

5. Preparation for class session:
   • Does the instructor have to have some kind of preparation prior to the instruction?
• Do students know what preparation (reading or other assignments) they should have completed prior to class?

6. **Instructional methods:**
   • List instructor’s activities.
   • Did the opening gain the class’s attention?
   • Is the delivery paced to students’ needs?
   • Does the instructor introduce topic, state goals, present material or activity effectively, summarize, and give assignment or suggest an idea to consider before the next class?
   • Could the instructor be seen and heard?
   • Were explanations clear to students?
   • Were examples, metaphors, and analogies appropriate?
   • Was the lecture stimulating and thought provoking?

7. **Opportunity for student participation:**
   • List students’ activities.
   • Does instructor encourage students to summarize and add to other’ summaries (concepts learned in previous sessions)?
   • Does instructor help quieter students interact with others?

8. **Individualization of instruction:**
   • Are the emotional, physical, and intellectual needs of students met?
   • Does the instructor prompt awareness of students’ prior learning and experiences?
   • Does the instructor offer “real world” application?
   • Is the instructor available before or after class?

9. **Responsiveness to student feedback:**
   • Is the instructor paying attention to cues of boredom and confusion?
   • Does the instructor encourage or discourage questions (dissension)?
• Does the instructor provide students opportunity to mention problems/concerns with the class, either verbally or in writing?

10. **Learning difficulties:**

• Does a student need assistance for a temporary or permanent disability?
• Are one or more students not motivated or unable to follow the class?
• Does the instructor show favouritism?
• Are students able to see visual aids?
• Do some students dominate discussion and hinder others’ participation?
Appendix C: Interview Guides

Interview Guide (for educators)

1. Introduction
   - What is the position you are holding at the school?
   - When did you observe/participate in Maths Dance sessions? How many sessions did you observe/participate? What was the age of the students attending the lesson?
   - Why did you choose to observe Maths Dance and what were your thoughts when you saw it?
   - Do you see Maths Dance either as an artistically or as a theoretically orientated process?

2. Cognitive domain
   - How do you estimate the importance of arts education (arts in general and dance in detail) for better understanding in maths?
   - How important is for you the integration of kinaesthetic activities in students’ learning in terms of memorizing and better understanding?
   - In what ways do you think that Maths Dance could encourage students’ critical thinking and analysis?
   - What kind of advantages or disadvantages you see in learning maths through Maths Dance? How could Maths Dance improve students’ maths skills?
   - In what ways could Maths Dance improve students’ creativity?
   - To what students would you recommend Maths Dance?

3. Affective domain
   - In how far could Maths Dance improve student motivation?
   - In what ways do you think that Maths Dance can encourage student participation in the learning process?
   - How could Maths Dance change students’ attitude towards maths, e.g. make them feel more comfortable with maths etc.?
4. Physical domain
   - According to your opinion, in what ways could Maths Dance improve students’ motor skills?

5. Conclusion
   - What did you expect before the observation and if it met your expectations after? How was the atmosphere during the lesson?
   - According to you observation what overall impressions do you think students have regarding Maths Dance?
   - Do you think that Maths Dance could be used by maths teacher as the main method of maths instruction?
   - What is your overall impression regarding Maths Dance? Do you think it’s worth spreading? Or alternatively, do you think that it can be part of a school curriculum? Could it be used by any teacher?
   - What specific suggestions would you make concerning how this particular class could have been improved?

   **Interview Guide (for students)**
   - Why did you choose to do Maths Dance?
   - Do you see it more as a maths lesson or as a dance lesson?
   - How do you feel when you have to dance with the other children in the Maths Dance?
   - How often and to whom do you talk about Maths Dance?
   - Would you recommend it to your friends and why?
   - What do you like more about Maths Dance?
   - What would you like to change in Maths Dance?
   - How would you describe your Maths Dance teacher?
Appendix D: Transcribed Interviews

Interviewee A

1. Introduction
- What is the position you are holding at the school?

*I am Thomson House School Principal.*

- When did you observe/participate in Maths Dance sessions? How many sessions did you observe/participate? What was the age of the students attending the lesson?

*I observed 2 sessions, one in October 2013 and one in January 2014. The students were 4 to 5 years old.*

- Why did you choose to observe Maths Dance and what were your thoughts when you saw it?

*Well, first one was to see if anyone wanted it to run as a club and second was to monitor it. I found that the first session was too advanced for our children but then Panorea adjusted it and the second one was very age appropriate and fun and I could see what the intention was.*

- Do you see Maths Dance either as an artistically or as a theoretically orientated process?

*I believe that Maths Dance can be seen both as an artistically and a theoretically orientated activity, it is both maths and dance.*

2. Cognitive domain
- How do you estimate the importance of arts education (arts in general and dance in detail) for better understanding in maths?

*I think it can have a positive effect.*

- How important is for you the integration of kinaesthetic activities in students’ learning in terms of memorizing and better understanding?

*I think it’s essential, whether it’s the whole body kinaesthetic or whether they are doing it with manipulating materials.*

- In what ways do you think that Maths dance could encourage students’ critical thinking and analysis?
I think it’s making those links so they’re just working out, you know, pattern, shape, spatial connections and spatial awareness, so it can help in that way.

- What kind of advantages or disadvantages you see in learning maths through Maths Dance? How could Maths Dance improve students’ maths skills?

Well, I think it’s about finding space and then Maths Dance can be one element of the learning, because then when you get to the more theoretical elements or, you know, yes, it could be a part of it.

- So can you not imagine Maths Dance as a method to teach more advanced mathematics?

I haven’t sort of thought about it in depth but I can’t imagine it being used for more advanced mathematics. I think it works perfectly for kinaesthetic learners, for developing number, shapes and space; I could see how that could be useful.

- In what ways could Maths Dance improve students’ creativity?

As an arts orientated activity, it can definitely improve their creativity. They use creative movement in various instances and the whole idea of understanding maths through movement is creative by itself anyway.

- To what students would you recommend Maths Dance?

It could help students with learning difficulties and also reluctant learners seem to have a block about what Maths is, you know, it could be a way into learning if they are resistant to some of the more traditional methods.

3. Affective domain

- In how far could Maths Dance improve student motivation?

It could definitely help in that way, improve students’ motivation etc. because it’s basically fun for everyone to participate.

- In what ways do you think that Maths Dance can encourage student participation in the learning process?

Yes, also that. I think it’s about making it more fun and enjoyable and it’s another element to the whole variety of activities that all skilled teachers should have and I think a good teacher will do very kinaesthetic things anyway; it might not necessarily be dance-based, but it will definitely very movement-based.
- How could Maths Dance change students’ attitude towards maths, e.g. make them feel more comfortable with maths etc.?

*Maths Dance could really work for students, especially in primary school, who think that maths cannot be an enjoyable topic.*

4. Physical domain

- According to your opinion, in what ways could Maths dance improve students’ motor skills?

*In the observation that I had, I could see that they were counting and moving and the language of maths is in there as well, you know, turning right, turning left, facing this way, that way, and I think that’s very important.*

5. Conclusion

- What did you expect before the observation and if it met your expectations after? How was the atmosphere during the lesson?

*It has met my expectations and I think that she has been very responsive to the group that she’s got. The first thing that I saw it was just too difficult for the children and then she’s just brought it down to exactly the right level and I found that there’s a lot of counting, a lot of group work, it encourages social skills, and yes, it met my expectations.*

- According to your observation what overall impressions do you think students have regarding Maths Dance?

*I didn’t see the whole session but I saw towards the end, so I saw the development, the product of the development and they were enjoying showing each other the work that they have done. So there was enjoyment and concentration actually, which was good.*

- Do you think that Maths Dance could be used by maths teachers as the main method of maths instruction?

*No, but it can easily be a part of it.*

- What is your overall impression regarding Maths Dance? Do you think it’s worth spreading? Or alternatively, do you think that it can be part of a school curriculum? Could it be used by any teacher?
It is something that could help. I think it’s a very worthwhile activity because there’s a lot of enjoyment and it could be very good at targeting certain groups and I think that a good maths teacher would use kinaesthetic methods anyway and you would see that in good maths teaching. When you are doing maths, you need to do real life maths, you go out in the street and do things with money and this and the other. A part of it might be if you are giving directions to someone; you might be in the hall or outdoors and doing physical movements, you know like the points of a compass etc., so all of that is happening already but not Maths Dance but I do think that it’s good. I think that for me the ideal would be to be offered either as a club or a supportive activity with the group, which is the way we see it so far in our school, but the way I see it being more useful would be integrated within the skill set of the teachers, so they might think “oh, let’s all get up, let’s all energise, we are going to do a bit of movement and dance”.

- What specific suggestions would you make concerning how this particular class could have been improved?

At the moment there are so many things that you see on the internet and web-based resources, there’s a lot of movement stuff to do with maths anyway and this takes it to the next level and it would be lovely if teachers could incorporate it in, so maybe there’s scope for training of teachers in this as part of the methodology which they could use as part of a variety of approaches.

Interviewee B

1. Introduction

- What is the position you are holding at the school?

I am a Year 4 teacher and Arts Coordinator.

- When did you observe/participate in Maths Dance sessions? How many sessions did you observe/participate? What was the age of the students attending the lesson?

Last year I joined Sports Week, which is a week we have towards the end of this term, the summer term, and we do all the assessments and a lot of the main work that has been going on through the year. That was one of the tasks we had to do. Don’t see this as something we do often in school, we have recently started doing it and that was a perfect opportunity for Panorea to present a cross curricular workshop between maths
and dance and it went really well. And that was last July. My children were, well, the class I got last year, most of them were 9 years old, so Year 4.

- Why did you choose to observe Maths Dance and what were your thoughts when you saw it?

I chose to observe Maths Dance because I needed to be there for a start, I needed to be there as a school observer, which was actually a very interesting experience. And since then Panorea was holding a Maths Dance session in the mornings for those children who found maths a bit of a struggle. So, it was interesting to see that before that went out. Basically I wanted to see how she could communicate to less able children the idea about sequential movement and putting things in orders etc., which I think she did pretty successfully, but not just for the less able children but also for the more able mathematicians, they were able to stretch themselves and put several sequences together using mathematical language, which went very very well.

- So, the initial idea why you introduced Maths Dance in the school was to help only students with problems, right?

Well, it was one of the things that was included in the Sports Week, but one of the reasons why I came and observe was also to see how we could bring this idea in the school and because one of my students joined Maths Dance in the mornings and it had helped him focus and put things in sequential order. And certainly it was interesting because it wasn’t aimed for a specific ability group, it wasn’t aimed for the less able children, but you could see that when Panorea taught him, he was able to solve and reply to questions that required mathematical knowledge. That worked really well.

- Do you see Maths Dance either as an artistically or as a theoretically orientated process?

When I saw it, I saw it more of a maths activity but it’s something that was dance, but it wasn’t totally dance, which is good I think, and although boys were quite rigid, all the children liked it and then discreetly they said “Oh, that was it? Yes, we had fun!”, but yeah, I would say more of a maths activity than a dance activity.

2. Cognitive domain

- How do you estimate the importance of arts education (arts in general and dance in detail) for better understanding in maths?
It’s interesting because there are certain links between arts and maths. You can look at famous paintings, like abstract paintings, Russian constructivism, you can look at a lot of geometrical shapes in some paintings, so the more you do that, the more there are mathematical things and formulas you can see in them, like 2 green and 3 red squares, there is a ratio between them. You can look at various different things that you probably didn’t think about them initially. With abstract art is quite easy to talk about maths rather than with figurative art. Better understanding in maths? Well, you can introduce shape-work through art. I think with children if you look at polygons and any other shape, the plastic resources that we have in our classrooms don’t really link to them things but through art you might be able to put things in contact.

- How important is for you the integration of kinaesthetic activities in students’ learning in terms of memorizing and better understanding?

I had a student last year that had a very short attention spanner and Panorea used to take her in Maths Dance sessions and she really struggled in putting things in sequential order and we thought how she would make it in a dance session with clapping etc., and she struggled there. But there is a fun element about that, so if you are doing clapping and clapping with your knees it’s a lot more fun rather than using numbers, rather than using symbols which are quite abstract. So, yes, that kind of thing. You can go to the playground and have fun, but still use patterns 1-2-3, counting, there is a lot more kinaesthetic. So, I can see that there is more connection in terms of kinaesthetic activities especially for preschool and primary school students, maybe less for secondary students. Year 4 and 5 that’s probably the highest you could go, then year 6 might think it’s silly but certainly preschool students would love that.

- In what ways do you think that Maths Dance could encourage students’ critical thinking and analysis?

Ah interesting...Well I’m trying to remember the session. So, if you got two children doing a movement 1,2,3,4,5,6 and then there is four punches and then there is three kicks or something, well then the child could say what can come after this, have you got seven kicks, have you got two kicks, have you got one kick, can we match them by having even numbers, is there anything that we can link in and they can find certain links. I think when the kids are doing it and learn it and it’s their own Maths Dance, then they will have more initiative about that. If you say “you do this and that” it’s a bit
more instructive. But if they create something, 6-4-2 or whatever, they can change that. So, in terms of that you could have more critical thinking.

- What kind of advantages or disadvantages you see in learning maths through Maths Dance? How could Maths Dance improve students’ maths skills?

Well again I will have to go back to the less able children and about things like counting, it sounds really basic, like repeating numbers and some of the methods of behaviour control in the British classroom might be clapping and then the children repeat that and then they are all focused, it could be as simple as that. Or if you do a movement, 1,2,3,4 and then they have to repeat it, you are clapping your knees four times, jumping out five times, can you repeat it backwards, can you build up three sequences, three movements and then repeat them backwards, can you four movements and then repeat them backwards and then can you do something similar five movements, four movements, three movements and then repeat the numbers 5-4-3 or 3-4-5, can you change it, and some of the children would say “oh, that’s the same like what we did with numbers, it’s easy” but it requires much more thinking. So, in that sense I believe it can improve short term memory and sequential thinking. I can name about 5 children here who would need that.

- In what ways could Maths Dance improve students’ creativity?

I’m thinking of boys specifically who don’t dance and they still feel a bit intimidated and silly, so that’s why we are trying to integrate more of a dance in the curriculum. Maths Dance, you could rename it to maths movement or something and the children need to understand that. You are quite free to create sequential movements or even shapes or even anything through movement, but yes, it does take quite of a lot for boys to get involved into it.

- To what students would you recommend Maths Dance?

Definitely for students who are less able in maths, but yeah, I think I answered this question previously.

3. Affective domain

- In how far could Maths Dance improve student motivation?

Yes, I would agree that it can promote motivation but you will have to be aware of partnerships in that. What we do in our school is to make sure we’re all partners in
practically all subjects (mixed ability), so you got those children who are less able being helped a lot by the more able, children who are very creative can help the ones that are more reserved, so that could help but it would depend upon the way that she might do it, how she could work with those children who frankly find dance kind of intimidating; but they could enjoy, it’s something that they should be quite up for; if you tell them it’s maths, then it might turn up as something bad; if you tell them it’s dance, you must be really really careful how you present things to them.

- In what ways do you think that Maths Dance can encourage student participation in the learning process?

Oh, well, it’s not sitting and learning, they can get up and do something. Some children like that but as I said before for those children who find certain concepts, ratio, sequences, shapes a bit of a challenge, it can really help. You have four children lying down on the floor in a square and something like that is Maths Dance, of course you can do more than that, it’s a bit more out of the class and out of the concept. And I also think that it might work well for some students, but it might not work for other students.

- How could Maths Dance change students’ attitude towards maths, e.g. make them feel more comfortable with maths etc.?

I would definitely say yes. I’m thinking of about 6 children who, because it’s quite fast paced, some of them would have to keep up and they would find it a bit of a struggle in the classroom; but in Maths Dance they can be more engaged, it’s more of an engaging opportunity for students because it’s quite fun, who cares if you make a mistake, we are all working towards the same goal.

4. Physical domain

- According to your opinion, in what ways could Maths Dance improve students’ motor skills?

Again, it will probably depend on their behaviour. Because there are certain children who just find dancing predictable and silly, but, if you have to be very precise in your movements and I remember this quite distinctly that Panorea with her movement, moving the hand and other dance sequences she was motivating the children to follow her. So, in this case you have to be very careful and aware of that. So, if children do have problems with their coordination, well then that would really help pushing them
up in different ways, so yes this maths training or dance training session, would help them work out special things, be aware and think “Is there someone close to me?” Same thing if you are working in groups, 2-4-6; you can try different movements and ask the children “Can you hold someone while you are doing this movement?” etc.

5. Conclusion

- What did you expect before the observation and if it met your expectations after? How was the atmosphere during the lesson?

I didn’t have any expectations. I was genuinely curious to see what the system was, we didn’t know how it would turn out, but it was quite interesting. I thought, that could really work and since then she had been teaching clubs in the mornings and some children were invited to do it. So, yeah, genuinely I didn’t have any expectations, I mean Panorea has worked with me one to one with some of the children but it was quite interesting to see her in a large group, she was able with quite simple movements to bring some children up. The children definitely enjoyed it. I think they’ll remember that week. It was in the beginning of it and I think they’ll remember Maths Dance as something that was really gentle, relaxed, something that didn’t require too much physical activity but what you were actually doing, was certainly physical. Of course, it did require previous knowledge in mathematics as well and if the children didn’t think it did, then it definitely did.

- According to you observation what overall impressions do you think students have regarding Maths Dance?

To some extent considering the title Maths Dance - was it too much dance, was it too much maths- I think the medium is fine, and with children you need to be aware of this and be very clever in the way you encourage them to participate in the activities, so that you can get those who are less engaged in either maths or dance.

- Do you think that Maths Dance could be used by maths teacher as the main method of maths instruction?

There is a restriction according to what specific subjects you could do, but certainly in preschool going up to Year 2 perhaps you could do a lot of the adding up because you are doing one digit numbers, sequential numbers put together, you could do that kind of thing.
- What is your overall impression regarding Maths Dance? Do you think it’s worth spreading? Or alternatively, do you think that it can be part of a school curriculum? Could it be used by any teacher?

I thought it was really good and since then I couldn’t see what Panorea has been doing to other places unfortunately, but I think it could certainly help with some of the less able children to kind of increase their self-confidence. I’m thinking of a girl in my class, she got short short-term memory, so, yeah, that would help with her. Well, her maths is brilliant when she is focused, but it takes her long time complete an exercise that requires combining skill. So, in that sense I would certainly recommend it to those children who have similar problems. Some of the children who are more capable, more able, they can be helped also and they can help children who are less capable, as I said before. And yes, for those reasons I could see Maths Dance as part of the school curriculum after relevant training.

- What specific suggestions would you make concerning how this particular class could have been improved?

Hmmmm…perhaps, I would say it would interesting to see if you had a complete whole class version and that was what Panorea was telling us; you’ve got 4 children here, can these four children link their sequential dance to another four children and the whole class can put together all their movements and they can work together in maths and that’s how the whole class can participate.

Interviewee C

1. Introduction
- What is the position you are holding at the school?

I’m the Maths Coordinator.

- When did you observe/participate in Maths Dance sessions? How many sessions did you observe/participate? What was the age of the students attending the lesson?

I observed one session of Maths Dance. The students were 7 and 8 years old.

- Why did you choose to observe Maths dance and what were your thoughts when you saw it?
Well, we had a group of children who came up into the Key Stage 2 sort of underachieving in maths and had a variety of different educational needs and we were just looking for other ways that we could help support their maths learning in class and Maths Dance seemed something quite different, so it might appeal to them and maybe make them see maths in a different way, because maths is something they don’t particularly enjoy.

- Do you see Maths Dance either as an artistically or as a theoretically orientated process?

I kind of saw it as 50-50, but I thought that there was a nice combination between maths and dance, especially for a lot of children who actually like dance, it might be that they see it more as dance and then the maths is just kind of sneakily put in there.

2. Cognitive domain

- How do you estimate the importance of arts education (arts in general and dance in detail) for better understanding in maths?

I think arts, in general, is really important. There are a lot of children with a lot of talent in there, even though it might not be, you know, a part of how school might judge them in terms of levels and everything, it’s actually a very important part of children’s lives. As arts and maths I don’t think that’s probably recognised very highly at all actually and there’s not much of a link, let’s not say that it should be, but I do think it should be developed and explored further.

- How important is for you the integration of kinaesthetic activities in students’ learning in terms of memorizing and better understanding?

It can definitely help students memorizing and better understand complex mathematical concepts and especially to understand the fact that maths can be practical first and then they can understand it on paper.

- In what ways do you think that Maths Dance could encourage students’ critical thinking and analysis?

Well, it’s hard to say judging only from one session that I observed but it might help them to understand possible mistakes or misconceptions. I think that when they are working in a group, it gives them more of an opportunity for them to discuss, for example “that worked, that didn’t work”, so it definitely encourages that kind of
discussion which will then lead in some mathematical discussion anyway. I guess in a lot of stuff they did there is quite a lot of paired work, so again it took two of them to kind of be able to complete the routine together, so they have to kind of help each other if one of them did go wrong, so it kind of helps them in this self-assessment.

- What kind of advantages or disadvantages you see in learning maths through Maths Dance? How could Maths Dance improve students’ maths skills?

I think the general point was that some of the boys weren’t that keen, because we picked a mixed group and that might be a stereotypical thing, yeah, because it’s quite often that girls choose dance, but boys weren’t so excited with the fact that it was dance. And maybe some of them felt slightly inhibited and a little bit shy maybe at first.

- In what ways could Maths Dance improve students’ creativity?

I think dance is very creative anyway and I think that just being able to make the links between maths and then make a dance out of it, that definitely encourages creative thinking. It gives them freedom to experiment different things which encourages creativity.

- To what students would you recommend Maths Dance? In the school is there any kind of information exchange related to students’ achievement on different subjects and do you discuss any interdisciplinary approach on solving the individual pupil’s problems, e.g. in maths?

The initial idea was to introduce it to students who had specific difficulties in maths, but not only just to address the difficulties but maybe also to change the perception of maths subject. I think that could be something that once children feel that have labelled themselves as not being very good at maths even at a very young age, then this is how they are going to talk about themselves “I’m not good at maths” and through Maths Dance they can see maths in a different way, like not be completely turned off by the subject and get anxious.

3. Affective domain

- In how far could Maths Dance improve student motivation?

If you got a child who is really not enjoying the subject and feels very anxious about it, then probably whatever you are trying to do is not going to be that successful, because the child is just not confident. Whereas, if we can at least change the attitude first of all,
then maybe this can help them understand difficult maths concepts. If they can start enjoying the process, then they will enjoy an aspect in maths and then they will be motivated to learn more.

- In what ways do you think that Maths Dance can encourage student participation in the learning process?

Like I said before, then fun element of Maths Dance can engage them in the learning process. If they enjoy the process, they are more willing to participate in the activities.

- How could Maths Dance change students’ attitude towards maths, e.g. make them feel more comfortable with maths etc.?

Once people tend to label themselves as not being very good at maths, then they keep that and they think they can’t change it, like it’s just a disability that you are born with, not being good at maths, and you are either a maths person or you are not. Even at that young age they start to think like this, so it’s good to provide them with different teaching strategies, a different approach to maths.

4. Physical domain

- According to your opinion, in what ways could Maths Dance improve students’ motor skills?

Well, I think them being required to do big movements and fine movements, they are having to do so many skills and move so much that they are –without even realising it– working on them. Obviously we have seen only a few topics being taught at the moment, but they were going from bigger movements to smaller movements and it was really good to see them develop different mathematical concepts through movement. I remember that there was also a bit of balance element involved when they were working with number bonds, so yeah I suppose that in lots of levels can Maths Dance improve their motor skills.

5. Conclusion

- What did you expect before the observation and if it met your expectations after? How was the atmosphere during the lesson?

From my point of view, I really didn’t know what to expect if I’m honest, so I kind of thought, you know, what it might look like but I didn’t really know, I didn’t really go in
thinking it would look one way or another, I couldn’t really understand how this is going to work. When we spoke about it in the school, we didn’t really know what to expect. We were enthusiastic about it, like something that it should really be explored but when we saw it we said “yeah, this is how she is doing it!”

- According to you observation what overall impressions do you think students have regarding Maths Dance?

I think there was a mixture of different attitudes; there were some a bit more self-conscious and I think that was generally the boys, yeah it was the boys who seemed a little bit, you know, held back in the beginning, and you know, maths and dance are not two things that you naturally put together, so therefore I think again they were a little bit uncertain because they didn’t know what it was going to be like. Although there were different levels of enthusiasm between boys and girls, they all went on with it and enjoyed the activities.

- Do you think that Maths Dance could be used by maths teacher as the main method of maths instruction?

That, I would say no, I don’t think so. Because coming from my perspective as a Year 6 teacher I think there’s definitely room for exploring different teaching ways, so we can still try new methods, I mean sometime you do put your book down and you need to find other ways to keep your students focused, so I think there might be room in the curriculum for it but I don’t think you could teach all of your maths through that. It could be part of it, but I don’t think it can be only that.

- Can you see Maths Dance being taught in higher levels of education, e.g. secondary schools?

It’s hard to say. I mean maybe it could be. I think I’ll predict something that might come in the way would be that I’m thinking of my Year 6 class some boys are just funny about dance anyway. When you say: “dance” they might be a bit sceptical about it. It’s not necessary that you couldn’t find ways to link certain topics, it’s just that I think that in a secondary school it might not go down so well because the kids might not feel comfortable with doing maths through dance.

- What is your overall impression regarding Maths Dance? Do you think it’s worth spreading? Or alternatively, do you think that it can be part of a school curriculum? Could it be used by any teacher?
I think it’s an idea worth spreading and exploring definitely. For me to recommend it to somebody else at this point, I would like to see more. It’s not that it’s not impressive what I’ve seen, it’s just that the idea of what I’ve seen so far, I definitely think it’s something worth exploring particularly with the younger children who are struggling with maths in order to give them that extra kick and it would be something worth exploring to put through the rest of the curriculum, but obviously you would need to consider training of teachers to be able to deliver Maths Dance and give them ideas of how they could relate certain topics to dance.

- What specific suggestions would you make concerning how this particular class could have been improved?

I think maybe making sure that Maths Dance is related to the units taught in the class. Since it’s an after school club, it would be helpful to identify the gaps and see what they didn’t get in the classroom and then bring it and work with this knowledge in the Maths Dance session, but, yeah, that would require more organization from the school but I’m sure that it would be good.

Interviewee D

1. Introduction

- What is the position you are holding at the schools you are teaching Maths Dance?

It depends. In most cases the schools invite and employ me to run Maths Dance workshops, clubs and CPD (Continuous Professional Development) sessions usually for a term or an one off session. In parallel to being the director of Maths Dance I also work as a maths teacher. I have taught Maths Dance in the schools that I work as a maths specialist either by incorporating Maths Dance within or externally to the curriculum.

- What type of professional, vocational or other work-related qualifications do you have?

I hold a BSc in Applied Mathematics, a MSc in Biomedical Engineering, an MA in Maths Education and QTS.

- What made you come up with the idea of Maths Dance? When did it start?
Maths Dance is the result of a longstanding interest I have had on the intersection of mathematics and dance. Having an academic background on Applied Mathematics and Biomedical Engineering and many years of working experience in the performing arts I have always considered the link between mathematics and dance. However, I first thought about the educational implications of this idea in 2009, when I started working as a maths teacher. During the 2009-2010 academic year I participated in a research project that took place in Kinitiras studio in Athens aiming to explore new ways of creating choreography and performance through mathematics. This yearlong project highlighted opportunities for further research. The next step I took in this dance flavoured mathematical journey was an MA in Maths Education at Roehampton University, London. My thesis was a case study on teaching mathematics through dance. After completing my research successfully, getting a distinction for my thesis, I took a step further founding Maths Dance. My aim became to contribute to the understanding of embodied and creative mathematics teaching and learning and to help make this approach accessible to as many maths educators and students as possible.

- What is the age of students that have attended Maths Dance so far? According to your opinion and experience, can it be applied to students of any age?

Since founding Maths Dance in January 2013 I have collaborated with primary schools and have worked with students aged 4 to 11 years old. That is students in Year Reception up to Year 6. However, Maths Dance can be taught to secondary schools as well. There are many KS3 and KS4 mathematical areas that can be approached, explored and communicated through movement. For example, sets of numbers, fractions, ratio and proportion, formulas, equations, coordinates and line graphs, angles, parallels, symmetry, translation and enlargement, representing data and probability. In the 2014 summer term Maths Dance will be taught to a college in the UK and in the 2014 autumn term we will work with secondary schools in London – this is something that we have already arranged and I really look forward to these collaborations. Maths Dance should not be seen as a replacement of current maths teaching strategies, but as an additional, cross curricular, kinaesthetic, creative and energetic pedagogical approach enhancing mathematics teaching and learning.

- Do you see Maths Dance either as an artistically or as a theoretically orientated process?
Maths Dance is about exploring, making sense of and communicating mathematics using our own moving bodies. It is an innovative, physical and fun way of teaching and learning curriculum mathematics through movement. Teachers can use Maths Dance as an educational tool to bridge emotional and mental activity with learning processes as well as to overcome the fragmentation of the curriculum and follow a holistic teaching approach. For children it is a way to develop and enrich their mathematical thinking and understanding, their creativity and their dancing and social skills. The relationship between mathematics and dance in a Maths Dance lesson is symbiotic, balanced and bidirectional. In that sense, there is an equal emphasis given to talking and thinking about maths and physically doing it.

2. Cognitive domain

- How do you estimate the importance of arts education (arts in general and dance in detail) for better understanding in maths?

Cross curricular education is not just about shared content but also about pedagogy. In that sense art, and in particular dance can have an invaluable impact and contribution to effective mathematics teaching and learning. Unfortunately especially during the last decade we have seen a great fragmentation of the curriculum to address specific goals such as improving numeracy targets. This has brought education back to a dualistic approach that had dominated the global educational system for centuries. Whilst the idea of a Maths Dance lesson is interesting I understand that there are doubts about how to integrate this practically into a maths class on a regular basis. In my CPD sessions and discussions with colleagues I welcome teachers to use Maths Dance as an educational tool to bridge emotional and mental activity with learning processes as well as to overcome the fragmentation of the curriculum and follow a holistic teaching approach. It doesn’t necessarily need to be a whole Maths Dance lesson – teachers can pick and incorporate in their lessons elements and separate activities of Maths Dance. Even a small element of embodied learning can have a huge impact on maths understanding and make a difference.

- How important is for you the integration of kinaesthetic activities in students’ learning in terms of memorizing and better understanding?
Maths Dance is a dynamic multisensory teaching and learning approach. A lesson which includes a variety of methods and stimuli (physical, visual and auditory) is likely to keep more children engaged and for more of the time than an approach that just relies on one single method. Thus, the stimulation of multiple sensory experiences (speech, actions, pictures, symbols) can enhance memorising and offer deeper understanding of a new concept. Furthermore, Maths Dance is informed by recent neuro-scientific research which stresses the importance of integrating movement activities into every-day learning. This is what brain-compatible learning is about: teaching mathematics and all other subjects along with movement, drama and the arts.

- In what ways do you think that Maths Dance could encourage students’ critical thinking and analysis?

All the activities are planned and developed with the aim to encourage students to engage in thinking about fundamental mathematical ideas and statements in a variety of situations and to respond physically with their own ideas through their moving bodies. For example, the main purpose of many of the activities we practise is the realisation that there are more than one answer to a question and the kinaesthetic experience of multiple solutions. Children became creative and came up with their own addition facts. It was a fun way to cultivate and support their high order thinking skills. Talking about maths and the correct use of the maths vocabulary is an intrinsic part of the activities. No matter how young or old the students are, no matter what mathematical area we are exploring we constantly use and refer to the relevant maths vocabulary. In that sense children are encouraged to vocalise their thoughts and discuss about their answers with the class.

Another important parameter that supports the development of critical thinking is that students are given the time they need to explore the mathematical concepts in depth. Our aim is to give every single student the space and the time to think. We don’t feel the pressure of covering every single area of the curriculum and meeting all the curriculum targets. If I see my students engaged in a mathematical discussion inspired by an activity that they just did, I prefer to give them the time they need to think out loud, talk and share their ideas rather than move on quickly to the next activity in order to cover what I have planned for that lesson.
- What kind of advantages or disadvantages you see in learning maths through Maths Dance? How could Maths Dance improve students’ maths skills?

From a cognitive and mathematical point of view Maths Dance provides perceptual variability in the delivery of a mathematical topic. The mathematical concepts are introduced in a different physical context. Students are encouraged to view these concepts from a different conceptual perspective. Perceptual and mathematical variability are the two parameters that enhance the two basic cognitive processes in maths: abstraction and generalisation. Mathematics becomes fun and entertaining. This automatically changes the students’ attitude towards the subject and increases the possibility of improving levels. Through our services we support schools to enrich their curriculum through creative and embodied maths classes and workshops of the highest quality. The extracurricular classes in the format of early morning and after school clubs support local families by offering peace of mind for working parents who need to balance work and family commitments.

In the forthcoming future we also plan to offer our services to schools with high percentages of pupils who are eligible for free school meals. Through this initiative Maths Dance will give the opportunity to children from disadvantaged backgrounds, who would never have the opportunity to participate to a dance lesson, to get extra support in maths or watch a dance performance with their parents, to experience mathematics through movement within the safe environment of their schools.

Very often the Maths Dance classes are mixed age, for example, Y1 and Y2 or Y3 and Y4. Learning in a mixed age group reflects some of the core values of Maths Dance: inclusiveness, respecting and valuing difference and working and creating together. Furthermore, it is a pedagogical approach aligned with recent research which indicates that children make the same or better progress in mixed-age classes than those in the same-age classes and develop a significantly more positive attitude towards school, themselves and others.

I can’t see any disadvantages in learning maths through Maths Dance. As I always say Maths Dance should not be seen as a strategy to replace or abolish ‘traditional’ maths teaching but rather as an alternative kinaesthetic and creative way to approach mathematical knowledge. As long as it is taught in parallel to classroom based maths teaching students can only benefit from Maths Dance.
- In what ways could Maths Dance improve students’ creativity?

Dance and creative movement cultivates creativity, both in an individual and collaborative level. Students are encouraged to use their imagination and creativity throughout the lesson. Additionally, in every Maths Dance lesson students engage in the creative process of building up maths-inspired choreographies.

- To what students would you recommend Maths Dance? In the school setting you have taught so far, is there any kind of information exchange related to students’ achievement on different subjects and do you discuss any interdisciplinary approach on solving the individual pupil’s problems, e.g. in maths?

Maths Dance is a lesson that can be taught to any student regardless of age, academic and artistic abilities and experience. It is an inclusive lesson. In all the schools that Maths Dance has already been taught we promote a holistic educational model, where the two ostensibly opposite curriculum subjects of mathematics and dance are linked and taught together.

We offer to the students a fun, entertaining and physical way of experiencing mathematics. At the same time we aim to raise the participant students’ engagement, understanding and performance in mathematics. For example, Henwick Primary School chose Maths Dance as a way to raise attainment in a group of 30 Y3 and Y4 students. We planned the lessons in collaboration with the students’ class teachers. We focused on specific areas that we knew that the students needed extra support.

Something similar happened last year, in Barnes Primary School: the class teachers suggested to the students’ parents to register their children to the Maths Dance clubs as they considered it a way to improve their understanding and therefore levels in maths. I regularly exchange information about my students with their teachers and their parents, as I aim to create a positive learning environment for every student, personalise my teaching to meet every single student’s learning and emotional needs and support them in the best possible way.

3. Affective domain

- In how far could Maths Dance improve student motivation?

It is a multisensory activating approach and very physical at the same time. The activities are open to everyone regardless of academic or artistic background. This
means that each student can explore and develop a mathematical concept in his/her own time. There is no pressure of being right or giving always the right answers. In the class our motto is “I love mistakes”. It’s about encouraging participation, it’s about engagement, it’s about discussing your opinions and trying to make sense of mathematics without being afraid of making mistakes. That’s the biggest motivation for them. They are not afraid to express their ideas and take risks, which makes their self-respect and self-esteem grows bigger. I also very often split the group into “mathematicians” and “dancers” and I then ask them to work on a task in pairs or small groups, where mathematicians work in collaboration with the dancers. Through this process they are all motivated to teach each other and share their knowledge with the group.

- In what ways do you think that Maths Dance can encourage student participation in the learning process?

As I said before, students participate in the learning process through group work, through sharing and teaching each other. The kinaesthetic approach helps learners to understand and remember the maths and the connections that are created through movement.

- How could Maths Dance change students’ attitude towards maths, e.g. make them feel more comfortable with maths etc.?

First of all, students feel ok with making mistakes. Secondly, I always make sure that the activities are all open-end and very often there are multiple answers to the questions I pose. They realise that there is not always and necessarily one correct answer to a mathematical question; consequently, their attitude towards maths changes.

4. Physical domain

- According to your opinion, in what ways could Maths Dance improve students’ motor skills?

It’s an approach that supports and cultivates children’s kinaesthetic intelligence. Maths Dance identifies the potential to excel in this intelligence. Movement is an intrinsic part of the learning process. The creation of the choreographies is also an important part of the lesson. Students inevitably improve their motor skills. It’s also important that I become a role model for kinaesthetic development. I move around all the time,
demonstrating the activities and showing them how to channel their energy into creative movement.

5. Conclusion

- What did you expect from Maths Dance before you actually started practising it to schools? Did it meet your expectations?

My only expectation at the beginning of this journey was to share my passion and my ideas with as many educators and students as possible. Many important steps have been taken so far. During the last year I have collaborated with many schools in London and also I have led CPD (Continuous Professional Development) sessions for teachers.

- What overall impressions do you think students have regarding Maths Dance? How would you describe the atmosphere during a typical Maths Dance lesson?

Students love Maths Dance. The atmosphere is always very positive. Of course it always takes a couple of weeks for the children to come closer as a group and understand the philosophy of the lesson but generally speaking I create a safe and positive learning environment where every single child is given the opportunity to excel.

- Do you think that Maths Dance could be used by maths teachers as the main method of maths instruction?

No. Maths Dance should not be seen as a replacement of the current teaching approaches. I welcome students to see Maths Dance as an alternative, kinaesthetic, creative way of introducing mathematical concepts and developing mathematical knowledge. If Maths Dance is taught in parallel to the “traditional” classroom-based Maths, it can only benefit the learning process.

- Do you think that Maths Dance can be part of a school curriculum? Could it be used by any teacher?

Yes, definitely. That would be great! Being part of the whole school curriculum Maths Dance would support a cross curricular and more holistic educational approach. Any teacher who has secure subject knowledge and who is not afraid to try something new can use Maths Dance.

- What specific suggestions would you make concerning how your Maths Dance classes could improve?
If we get funding, we will be able to offer Maths Dance in more schools at a very low cost giving the opportunity to students especially in disadvantaged areas to experience it. For me this would be very important. Furthermore, Maths Dance is evolving and changing continuously. The lessons, and myself as well, have definitely been improved during the last year and I am confident that I will say the same thing in one year from now. I always ask feedback from other teachers and the participants to the workshops that I am offering, and one of the suggestions I had was to develop Maths Dance further as an approach to cover special educational needs.

- Why do you think that Maths Dance is worth spreading?

It bridges mental and emotional activity with learning processes. It is innovating and supports a holistic educational scheme. It develops mathematical thinking and understanding, enriches mathematical knowledge and develops dance and social skills as well.

Preschool X students focus-group interview

- What do you like about Maths Dance?

Preschool X/Child A: That we dance!
Preschool X/Child B: That we learn more maths and I like maths.
Preschool X/Child C: I like dancing, so I like Maths Dance.
Preschool X/Child D: I like it because you dance.
Preschool X/Child B: I like it because when we do Maths Dance, we do games with maths and this is what I like.

- Is there something that you don’t like in Maths Dance?

Preschool X/Child A: In general I am shy telling something but I’m not shy in Maths Dance.

- How often and to whom do you talk about Maths Dance?

Preschool X/Child A: I talk to my friends.
Preschool X/Child B: I do also.
Preschool X/Child C: I don’t talk.
Preschool X/Child D: I talk to my parents about Maths Dance and I tell them what I like.

- When they ask you “What is Maths Dance?”, what do you reply to them?
Preschool X/Child A: It's dancing.
Preschool X/Child B: You do maths, you count.
Preschool X/Child C: I do counting up and down and then I dance.

- Would you like to continue doing Maths Dance and why?

Preschool X/Child A: Yes, because it’s fun!
Preschool X/Child B: Me too, yes!
Preschool X/Child C: Yeah!
Preschool X/Child D: Yes!

Primary School 1/Student

- How long have you been attending the Maths Dance lessons?
I started this year.
- Why did you choose to do it?
It's fun because it's maths which is quite fun and I love the songs and the dances we do and all of this stuff.
- Do you see it more as a maths lesson or as a dance lesson?
Both.
- How do you feel when you have to dance with the other children in the Maths Dance?
I don’t feel shy, I enjoy it.
- How often and to whom do you talk about the Maths Dance?
I was going to tell my mom about it but we didn’t really have time.
- Would you recommend it to your friends and why?
I’m not sure, I might do, because we really have to do a lot of work here at the school every day and stuff.
- What do you like more about Maths Dance?
Well, you do really fun dances and I really like the way we did the dancing because it’s really fun. You do maths with your body which is quite fun. And I like the fractions. Because you dance to a fraction.
- What would you like to change in Maths Dance?
Hmm, I don’t know. I like it like this. Maybe it could be more fun if more children wanted to come.
- How would you describe your Maths Dance teacher?

_She is really really nice and she is a really good teacher._

**Primary School 2 students focus-group interview**

- Why did you choose to do Maths Dance?

_Please give your answers._

_Please give your answers._

_Please give your answers._

_Please give your answers._

_Please give your answers._

_Please give your answers._

_Please give your answers._

- Do you see it more of a maths activity or more of a dance activity?

_Please give your answers._

_Please give your answers._

_Please give your answers._

_Please give your answers._

_Please give your answers._

_Please give your answers._

_Please give your answers._

- How often and to whom do you talk about Maths Dance?

_Please give your answers._

_Please give your answers._

_Please give your answers._

_Please give your answers._

_Please give your answers._

_Please give your answers._

- And how would you explain to them what is Maths Dance?

_Please give your answers._

_Please give your answers._

_Please give your answers._

_Please give your answers._

_Please give your answers._

_Please give your answers._

_Please give your answers._

- How do you think that Maths Dance could help you improve in maths?

_Please give your answers._

_Please give your answers._

_Please give your answers._

_Please give your answers._

_Please give your answers._

_Please give your answers._

- What do you like more in Maths Dance?

_Please give your answers._

_Please give your answers._

_Please give your answers._

_Please give your answers._

_Please give your answers._

_Please give your answers._

_Please give your answers._
Primary School 2/Child B: It’s really fun to dance like numbers and shapes! I enjoy it a lot!

Primary School 2/Child C: I like moving and running. I liked the music also! It’s better than sitting in the same position and write.

- Is there something that you would like to change in Maths Dance, something that you don’t like?

Primary School 2/Child A: I like it. I wouldn’t change anything.

Primary School 2/Child B: I would like more children to come and do it with us.

Primary School 2/All: Yes, more children.

Primary School 2/Child C: The teachers talked to all the children about it, so maybe more children will come.
Appendix E: Lesson Plans

Maths Dance lunchtime club – Preschool X

Date
Friday 07.03.14

<table>
<thead>
<tr>
<th>MATHS Learning Objectives</th>
<th>(Year Reception)</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Count in ones forwards and backwards beginning with 1, or from any given number.</td>
<td>• Count in ones forwards and backwards beginning with 1, or from any given number.</td>
</tr>
<tr>
<td>• Read, write and interpret mathematical statements involving addition.</td>
<td>• Read, write and interpret mathematical statements involving addition.</td>
</tr>
<tr>
<td>• Represent and use number bonds within 5 and 10.</td>
<td>• Represent and use number bonds within 5 and 10.</td>
</tr>
<tr>
<td>• Compare mass or weight (e.g. heavy/ light, heavier than, lighter than).</td>
<td>• Compare mass or weight (e.g. heavy/ light, heavier than, lighter than).</td>
</tr>
<tr>
<td>• Compare lengths and heights (e.g. long/ short, longer/ shorter, tall/ short).</td>
<td>• Compare lengths and heights (e.g. long/ short, longer/ shorter, tall/ short).</td>
</tr>
<tr>
<td>• Sequence events in chronological order using language such as: before and after, next, first.</td>
<td>• Sequence events in chronological order using language such as: before and after, next, first.</td>
</tr>
<tr>
<td>• Recognise and name common 2-D shapes (e.g. rectangles, circles and triangles).</td>
<td>• Recognise and name common 2-D shapes (e.g. rectangles, circles and triangles).</td>
</tr>
<tr>
<td>• Describe position, directions and movement.</td>
<td>• Describe position, directions and movement.</td>
</tr>
<tr>
<td>• Describe position, directions and movements, including half, quarter and three quarter turns.</td>
<td>• Describe position, directions and movements, including half, quarter and three quarter turns.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>DANCE/ Movement Aims</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>• To explore different actions and gestures with others and in a specific sequence.</td>
<td>• To explore different actions and gestures with others and in a specific sequence.</td>
</tr>
<tr>
<td>• Use six basic dance actions (travel, turn/ rotation, jump, stillness, fall, gesture).</td>
<td>• Use six basic dance actions (travel, turn/ rotation, jump, stillness, fall, gesture).</td>
</tr>
<tr>
<td>• Use isolated parts of the body: joints, muscles, limbs, or surfaces. Example: nose, elbows, spine, thigh, shoulder, sole of foot, etc.</td>
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</tr>
<tr>
<td>• Timing/ Variations of speed and rhythm. Example: stillness, slow motion, slow, regular or even beat, fast, repetition, irregular beat. Double time: twice as fast. Half time: half the</td>
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</tr>
</tbody>
</table>
- Creation of phrases (a movement combination or section of choreography).
- Creation and composition of dance (choreography).

### Key Vocabulary

| Dance: | gesture, action, small, medium, big, stretch, fast, slow |
| Maths: | number facts, count on, count back, how many…?, order, first, second, third,…, long, short, tall, wide, narrow, thick, thin, heavy/ light, before, after, next, last, quick, slow, shape, curved, straight, round, circle, square, corner, left and right, top, middle, bottom, in front of, between, around, near, close and far, up and down, forwards and backwards, inside and outside, turns, clockwise, anti-clockwise, |

### Timing

<table>
<thead>
<tr>
<th>Lesson Structure</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>12.30 – 12.40</strong></td>
</tr>
<tr>
<td><strong>Warm-up</strong></td>
</tr>
<tr>
<td><strong>Shaking: Introducing counting with body actions</strong></td>
</tr>
<tr>
<td>Shake the right hand 8 times, shake the left hand 8 times, shake the right foot 8 times and the left foot 8 times. Now divide by 2 and shake 4 times. Divide by 2 again and shake 2 times, and finally divide again and shake each part once. Have the children count out aloud.</td>
</tr>
<tr>
<td>Bouncing</td>
</tr>
<tr>
<td>Follow the same counting format but the body action is feet in parallel, bending the knees and lightly bouncing. We change direction at each set of counts (North-South-East-West).</td>
</tr>
<tr>
<td><strong>12.40 – 12.50</strong></td>
</tr>
<tr>
<td><strong>Focus Game on Measures: Pass the object</strong></td>
</tr>
<tr>
<td>Stand in a circle. Pass an imaginary object to the next person. Act out to show how big/ small, heavy/ light, long/ short it is. Next person then creates a new object of their choice. Continue around the circle.</td>
</tr>
<tr>
<td><strong>12.50 – 13.00</strong></td>
</tr>
<tr>
<td><strong>Focus Game on Time and Direction</strong></td>
</tr>
<tr>
<td>Give each area of the room an action (e.g. North is reaching up in a vertical position, South is turning, East is making a gesture and West is lower down level close to the floor).</td>
</tr>
</tbody>
</table>
Introduce different speeds for travelling from one area to the other: Speed 1 is slow walking, Speed 3 is fast walking. The teacher calls out an area and also gives instructions for the speed, e.g. North with speed 1.

<table>
<thead>
<tr>
<th>Time</th>
<th>Activity</th>
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</thead>
<tbody>
<tr>
<td>13.00 – 13.10</td>
<td><strong>Creative Task on Number Bonds to 10: Number 10 sculptures</strong></td>
</tr>
<tr>
<td></td>
<td>The first person in each pair chooses a secret number smaller than 10: 0,1,2,3,4,5,6,7,8,9.</td>
</tr>
<tr>
<td></td>
<td>The partner needs to touch him or her with as many parts of his/ her body as the number needed to be added to the secret number to make 10. Each pair makes a 10.</td>
</tr>
<tr>
<td></td>
<td>E.g. If Yaye chooses 6, I need to touch her with 4 parts of my body (6+4=10).</td>
</tr>
<tr>
<td></td>
<td>When they create the first sculpture the other person chooses a number 0-9 and his partner touches him with as many parts of his body to make 10. And so on.</td>
</tr>
<tr>
<td>13.10 – 13.15</td>
<td>Practise the choreography:</td>
</tr>
<tr>
<td></td>
<td>1- Shaking</td>
</tr>
<tr>
<td></td>
<td>2- Bouncing</td>
</tr>
<tr>
<td></td>
<td>3- North – South – East – West</td>
</tr>
<tr>
<td></td>
<td>4- Number 10 sculptures</td>
</tr>
<tr>
<td>13.15 – 13.20</td>
<td>Perform choreography</td>
</tr>
<tr>
<td>13.20 -13.30</td>
<td>Interview</td>
</tr>
<tr>
<td>Maths Dance afterschool club – Primary School 1</td>
<td></td>
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<tr>
<td>-----------------------------------------------</td>
<td></td>
</tr>
<tr>
<td><strong>Date</strong></td>
<td>Thursday 06.03.14</td>
</tr>
<tr>
<td><strong>MATHS</strong></td>
<td><strong>Key Stage 1 (Y2)</strong></td>
</tr>
</tbody>
</table>
| Learning Objectives | • Recognise, create and describe patterns and using them to make predictions.  
• Count in ones, twos, threes, fours, fives  
• Recognise, find, name and write fractions 1/3, ¼, 2/4 and ¾ of a length, shape, set of objects or quantity.  
• Order and arrange combinations of mathematical objects in patterns  
• Use mathematical vocabulary to describe position, direction and movement. |
| **DANCE/ Movement** | To explore different actions and gestures with others and in a specific sequence. |
| Aims | **Key vocabulary** |
| Dance: gesture, action, small, medium, big, stretch, fast, slow |
| Maths: count up to, pattern, repeating pattern, rule, terms of the pattern, continue, predict, sequence, part, equal parts, fraction, one whole, one half, two halves, one quarter, two…three…four quarters, route, higher, lower, clockwise, anti-clockwise, turn, . |
| **Timing** | **Lesson Structure** |
| 15.00 – 15.40 | **Warm-up** |
| | In a circle – name game big, medium and small. All try shapes for the three different sizes. Then in a circle one by one say your name and make a shape (big, middle, small) all the children repeat the name and the shape. |
| | Walk on different pathways around the room on your own. |
| | The teacher introduces speeds 1-3. 1 is slow, pigeon steps and 3 is fast walk. As the children walk around the room call a number and |
they must walk to that speed.
The teacher then brings in the commands big, medium and small and
the children respond with shapes. They start walking again when the
teacher says a number.

<table>
<thead>
<tr>
<th>15.40 – 15.50</th>
<th><strong>Creative Task on Patterns</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>In pairs the students create a sequence of 3 actions using the big, small, medium shapes that they practised in the warm up activity. Try half the group reversing the pattern and performing at the same time as the other group 1 does: X,Y,Z,X,Y,Z,X group 2 does: X,Z,Y,X,Z,Y,X</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>15.50 – 16.00</th>
<th><strong>Practise choreography</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1-  Walking clockwise and anticlockwise in a circle and counting 8,4,2,1 steps 2- North, South, East, West 3- Fractions 4- Reversing the pattern</td>
</tr>
</tbody>
</table>

| 16.00 – 16.05 | Perform the choreography |
| 16.05 – 16.15 | Interview |
# Maths Dance afterschool club – Primary School 2

<table>
<thead>
<tr>
<th>Date</th>
<th>Friday 07.03.14</th>
</tr>
</thead>
</table>

## MATHS Learning Objectives

**Key Stage 2 (Y3)**

To help the children experience multiplication through movement.

Recall and use multiplication facts for all the time tables.

Show that multiplication of two numbers can be done in any order (commutative).

## DANCE/ Movement Aims

To Explore Different Qualities of Actions in Space

## Key vocabulary

### Dance:
- gesture, action, small, medium, big, stretch, fast, slow,
- angular movements, curved movements, space, relationships

### Maths:
- lots of, groups of, times, multiply, multiplication,
- multiplied by, multiple of, product, once, twice, three times,
- …ten times, repeated addition, double, halve, divide, shape,
- curved, straight,

## Timing

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</tr>
<tr>
<td>15.40 – 15.50</td>
</tr>
<tr>
<td><strong>Focus Game on Shapes: Conversation in Shape</strong></td>
</tr>
<tr>
<td>In groups of 2, 3, 4: Label yourselves angular or curved.</td>
</tr>
<tr>
<td>A creates a shape (angular or curved) that can be held for a</td>
</tr>
</tbody>
</table>
long time. And freezes. While A is frozen holding the shape, B
without touching A makes a shape on a different level, creating
a design with the first shape by filling some of the spaces
(between the legs, around the torso, under the arms). And
freezes. C needs to wait for his two partners to complete their
movements before he can move in creating his shape around
the others. As each child freezes, the partner creates a new
shape relating to the design of the frozen shape.

This is called ‘conversation in shape’, because no two people
are moving at the same time – the way no two people would be
speaking at the same time. Each new shape responds to the
shape made by the partner the same way we respond to the
people we are talking with. It is a silent kinaesthetic
conversation.

15.50 – 16.05

Creative Task on Multiplication

I. To demonstrate multiplication: 4x2
2 students standing together. Then I add 2 more, 2 more, and 2
more until they are 4 pairs. Count the number of the students
standing.

II. To demonstrate the concept of multiplication: 4x3
Four students stand next to each other.
Each is jumping 4 times.
Let’s count how many jumps altogether, while they jump one
at a time.
(The first student jumps 1, 2, 3; The second student jumps 4, 5
and 6; The third student jumps 7, 8 and 9 and the last student
jumps 10, 11 and 12 ). That was like adding 3+3+3+3 to get 12!
If we want to see how multiplication works, let’s have the
children do three jumps each but at the same time. How many
jumps did we see altogether? Did it take as long as when
<table>
<thead>
<tr>
<th>Time</th>
<th>Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>16.05 – 16.10</td>
<td>Have the children create their own multiplication facts and perform for the group. The audience needs to write the multiplication fact that they see on their white boards.</td>
</tr>
</tbody>
</table>
| 16.10 – 16.15 | Practise the choreography:  
5- Shaking  
6- Conversation in shape  
7- Multiplication facts |
| 16.15 – 16.20 | Perform choreography                                                      |
| 16.20 -16.30 | Interview                                                                |
Appendix F: Photos

Primary School 1

Students trying different movements with their bodies

Group activity with shapes
Creative task on patterns

Practice choreography with numbers
Creating shapes big, medium, small

Listening to the instructions for the activity
Preschool X

Practising fast and slow

Counting with body actions
Practise choreography North-South-East-West
Performing choreography “10 Sculptures”